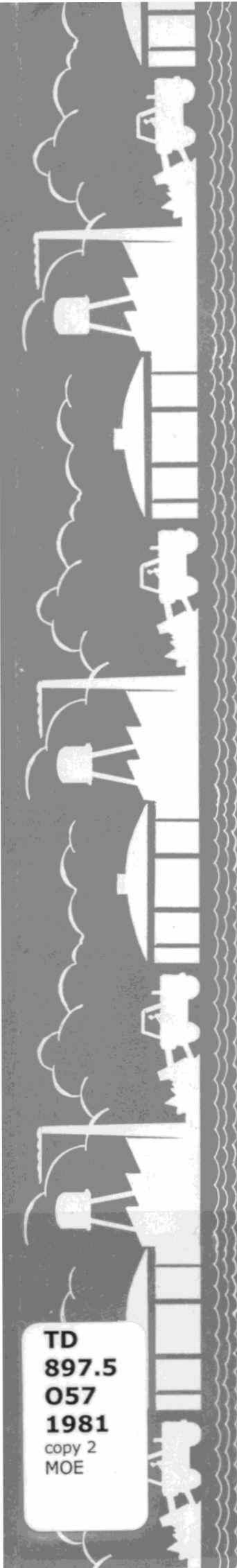


PROCEEDINGS

28th Ontario Industrial Waste Conference
June 14 – 17, 1981
The Prince Hotel
Toronto, Ontario

Ontario

Ministry
of the
Environment

Hon. Keith C. Norton, Q.C.,
Minister

Gérard J. M. Raymond
Deputy Minister

Date Due

Proceedings of the Twenty-eighth Ontario Industrial Waste Conference

held at

The Prince Hotel
Toronto, Ontario

June 14-17, 1981

Sponsored by the
Ontario Ministry of the Environment

CONTENTS

ONTARIO INDUSTRIAL WASTE CONFERENCE HISTORICAL DATA

Location	**Dates**	**Sponsor**
Ontario Agriculture College, Guelph	1954 to 1956	Pollution Control Board of Ontario
Delawana Inn, Honey Harbour	1957 to 1963	Ontario Water Resources Commission, Water & Pollution Advisory Committee
Bigwin Inn, Lake of Bays	1964 & 1965	Ontario Water Resources Commision, Water & Pollution Advisory Committee
Park Motor Hotel, Niagara Falls	1966 & 1967	Ontario Water Resources Commission
Sheraton Brock Hotel, Niagara Falls	1968 to 1971	Ontario Water Resources Commission
Skyline Hotel, Toronto	1972 to 1974	Ontario Ministry of the Environment
The Prince Hotel, Toronto	1975 to 1981	Ontario Ministry of the Environment

Conference Chairman	**Dates**	**Secretary / Co-Ordinator**
Dr. A. E. Berry	1954 to 1962	D. S. Caverly / M. Grove
D. S. Caverly	1963 to 1973	L. M. Tobias
K. H. Sharpe	1974 to 1976	M. J. Cathcart (1974)
D. P. Caplice	1977 & 1978	
J. W. Giles	1979 to 1981	M. F. Cheetham - 1975 to 1981

Program Conveners

1960-1973	F. A. Voege
1974-1978	J. B. Patterson
1979-1981	R. C. Stewart

PREFACE TO THE PROCEEDINGS OF THE 28th ONTARIO INDUSTRIAL WASTE CONFERENCE

On behalf of the Conference Planning Committee and the Technical Program Committee, I extend our appreciation to all those who contributed to the success of the 28th Ontario Industrial Waste Conference. Again registration for the Conference was well over the 500 mark - actually 577 participants, a standard of participation we have maintained since 1976, the first year we surpassed the 500 level.

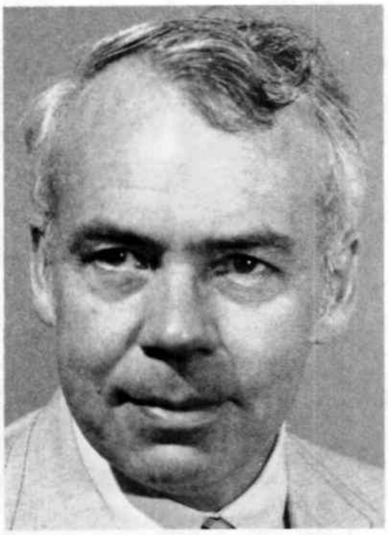
A special thanks to the session chairmen, program participants and all those who were involved in formulating the agenda in such a manner that the end result was beneficial to all those who attended. The papers were well-prepared, the content timely, the presentations well-received, and the management of each of the sessions by their respective chairmen so professional that the entire program adhered to the timetable throughout. The Technical Program Commitee members. and the Conference Planning Committee, deserve my particular acknowledgement for their individual contribution and effort to assure that the 28th Conference maintained the high standard that has become the hallmark expected by those who attend.

The Ontario Ministry of the Environment, the sponsor of the Conference, thanks each registrant for their continued participation. The following Proceedings are a permanent record of what transpired at the 28th. The 1982 Industrial Waste Conference will again be held at the Prince Hotel in Toronto. The dates for our 29th Conference are June 13-16. Of course you and your associates are invited to attend and we look forward to seeing you join with us in maintaining the high degree of interest in industrial abatement, pollution control and waste management that is singularly significant about our Conference.

J. Walter Giles,
Conference Chairman

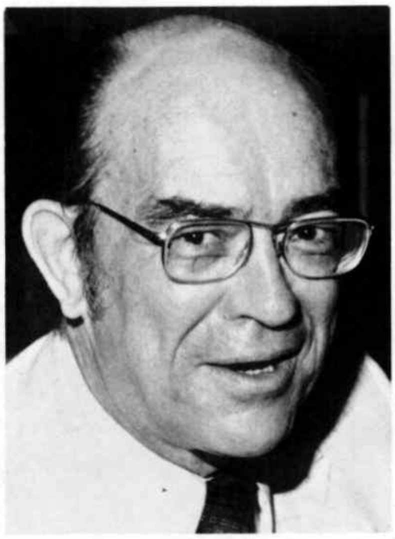
CONFERENCE PLANNING COMMITTEE

Conference Chairman
J. W. Giles, Assistant Deputy Minister, Environmental Assessment and Planning, Ontario Ministry of the Environment



Vice-Chairman
C. J. Macfarlane, Director Waste Management Branch, Ontario Ministry of the Environment

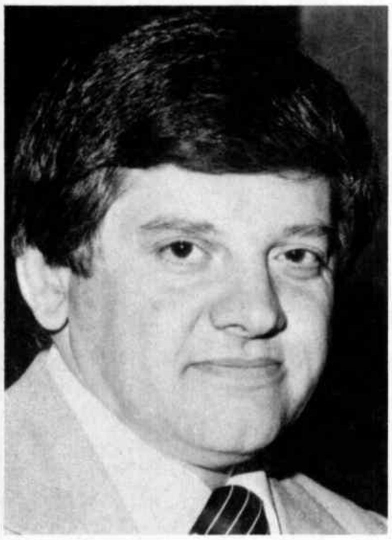
Program Convener
R. C. Stewart, Manager Technical Support, West Central Region, Ontario Ministry of the Environment



Conference Co-Ordinator
M. F. Cheetham, Public Affairs Co-Ordinator, Information Services Branch, Ontario Ministry of the Environment

TECHNICAL PROGRAM COMMITTEE

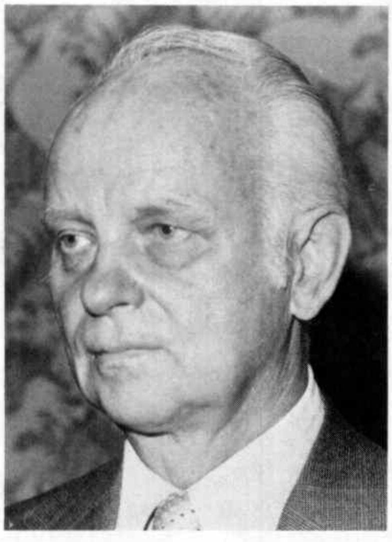
N. Borodczak, Manager, Municipal and Private Approvals Section, Environmental Approvals Branch, Environment Ontario



B. Boyko, Manager, Industrial Section, Waste Management Branch, Environment Ontario

C. E. Duncan, Hazardous Contaminants Co-Ordinator, Resources Management, Environment Ontario

J. Hawley, Head, Inorganic Unit, Quality Protection Section, Water Resources Branch, Environment Ontario

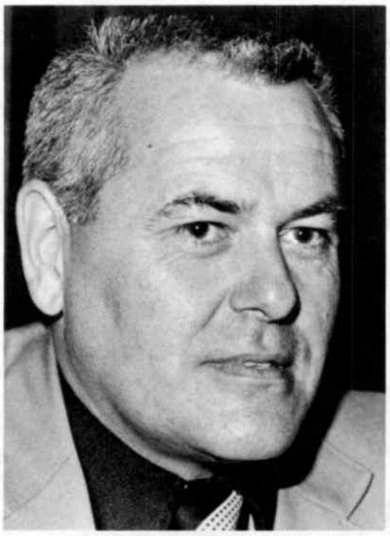


P. Kupa, Head, Regulation and Environmental Assessment Unit, Air Resources Branch, Environment Ontario

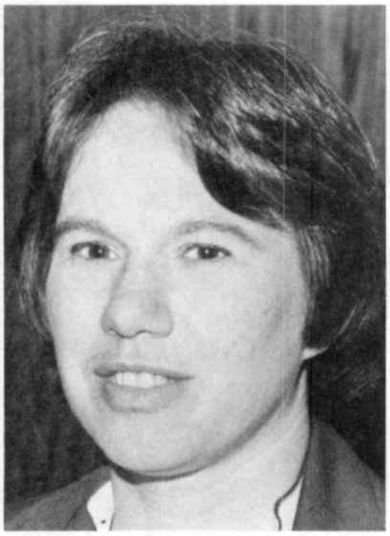
SESSION I - ZERO VS ACCEPTABLE RISK

Chairman: Dr. A. E. Robinson, Assistant Deputy Minister, Occupational Health and Safety Division, Ontario Ministry of Labour, Toronto

Professor Anne V. Whyte, Institute for Environmental Studies, University of Toronto, Toronto, Ontario



Dr. George C. Becking, Chief Environmental and Occupational Toxicology Division, Health and Welfare Canada, Ottawa



Dr. Nancy K. Kim, Director, Bureau of Toxic Substances Management New York State Department of Health, Albany, N.Y.

GENERAL CONCEPT OF RISK: RISK IN PERSPECTIVE

Professor Anne Whyte
Institute for Environmental Studies
University of Toronto

Ten years ago, the idea of risk assessment was familiar to only a relatively few people who specialised in the technique of risk analysis. Today, it is a term used often in the newspapers and on radio and television programmes. The public are becoming more aware of risks and risk assessment, and are increasingly expecting more of all of us in doing risk analysis.

The Mississauga train derailment emergency of November 1979 is only one example of an event which demonstrated to the public how comparatively little we, in Canada, have done in risk analysis. The derailment highlighted that, at that time, no studies had been done to assess by which routes, at which times of day, or whether by road or rail, it would be safest to transport dangerous goods through our cities.

What I would like to do in this paper is to:

1) start with some important definitions
2) discuss some of the framework issues in risk assessment
3) show how risk perception, particularly the perceptions of the general public, differ from risk analysis.

FIRST, some definitions.

1. RISK

The word 'risk' has two distinct meanings. It can mean 'a hazard or a danger' or it can mean the probability or chance of encountering some loss.

That is, it can either refer to the hazard itself or to the probability of the hazard.

For example, 'flood risk' is used both to mean floods, and more narrowly, a specific probability of flood such as the 100 year flood.

To some extent, it is true that the probabilistic definition is the more technically preferred one whereas the layman equates risk with hazard.

2. IMPACT ASSESSMENT

To some extent also, risk assessment can be seen as an historical development from impact assessment.

The first assessments dealing with evaluating effects, or impacts, did not use probabilistic techniques. As the problem being assessed became more complex, it became clear that both the nature of the impacts and the possibility of whether they would occur or not, was highly uncertain.

To deal with these uncertainties, assessments began to make use of mathematical techniques and, in particular, probabilistic theory and models of stochastic processes.

Thus, impact assessments became more sophisticated and with the growing use of probability, the term risk assessment became increasingly used, especially in the United States.

According to this view, the difference between 'impact assessment' and 'risk assessment' is that impact assessments are concerned with events that are reasonably certain to occur while risk assessment is concerned with events that may possibly occur.

Upon closer inspection, the difference between certain and probabilistic events appears not in the nature of the events themselves but in the degree of our understanding of them.

3. RISK ANALYSIS OR RISK MEASUREMENT

Risk analysis, then, is a formal method of determining the degree of risk. It is concerned with the measurement, or estimation, of both the probability of an event occuring and of the magnitude of its consequences.

Risk analysis is an intendedly rational, objective, scientific approach that consciously seeks to exclude emotive aspects and value judgements.

In practice, value judgements have to be made - for example, about what to measure - but the intention is to be objective and to show where and how 'non-rational' considerations enter the analysis.

Risk analysis uses techniques such as fault trees and event tree analysis; product quality tests, epidemiological surveys and tests for mutagenicity and the toxicity of chemicals, and so on - techniques which each have uncertainties and problems attached to them.

4. RISK ASSESSMENT

I would like to make a clear distinction between risk analysis - the formal, normative approach to risk measurement, and risk assessment - which is concerned not only with measuring risk but also with evaluating their acceptability.

Figure 1. Structure for risk assessment.

Thus, risk assessment can be considered as the overall framework into which technical studies, public response, and management capability combine to make public policy about risks (Figure 1).

Two important features of the assessment framework are: first, its emphasis on modelling the problem to be assessment, and second, its role in providing a comparative framework to make the assessments meaningful.

MODELLING RISKS

Ideally, risk models should be as detailed, comprehensive and as quantitative as possible. They are rarely any of these. Part of the problem lies in our inadequate understanding of the connections between the sources - pathways - and receptors of a risk.

Another problem lies in the natural variability in space and time which is characteristic of the environment and makes it difficult to separate signal from noise - this, in fact is one of the major headaches in

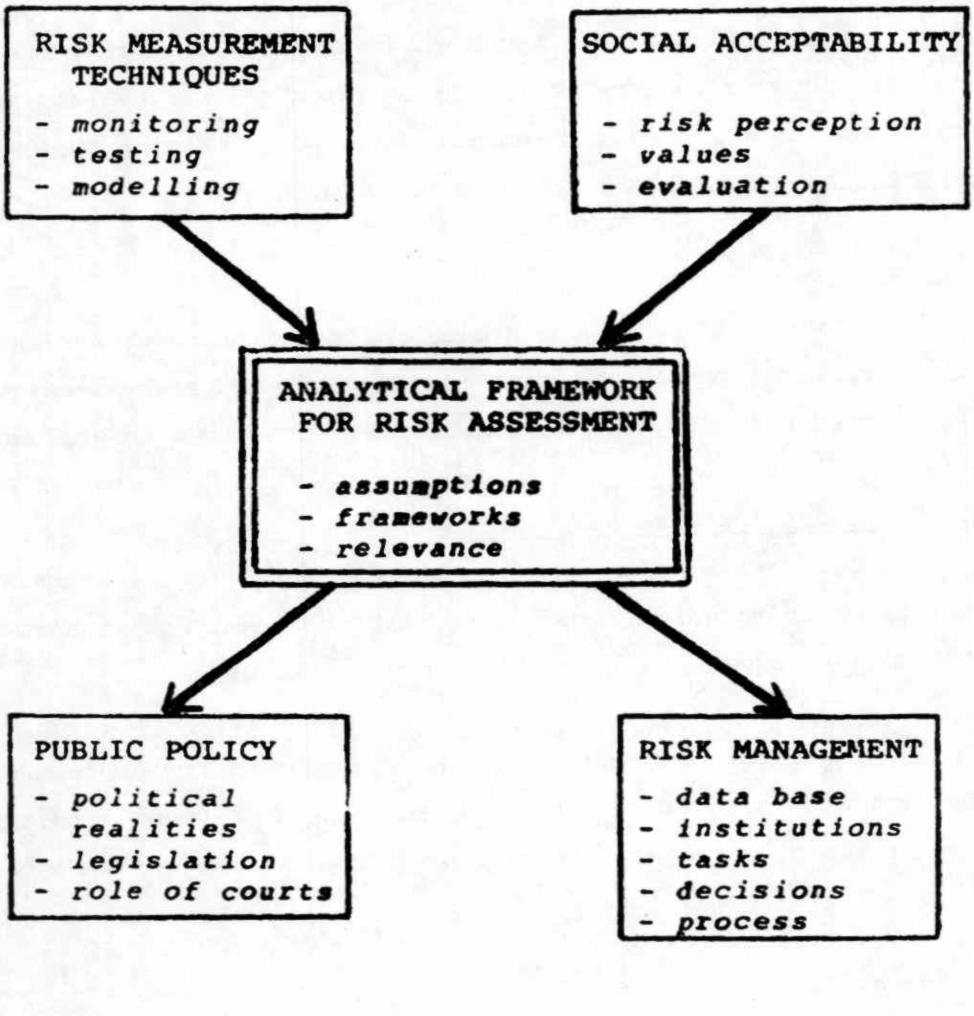


FIGURE 1. **STRUCTURE FOR RISK ASSESSMENT**

risk assessment - to differentiate what is a significant signal from background 'noise'.

For example, the day to day, month to month and year to year variabilities of stratospheric ozone are very large, so that it is very difficult to detect if there are any long term trends. Indeed, it has been estimated (Pittock 1974) that if a 2% depletion of stratospheric ozone were to occur now and suddenly, an additional 10 years of observations would be needed to confirm the change with 95% confidence.

The aim in modelling risks is to understand how the sources are linked to the receptors, and by what pathways.

Figure 2. Model of DDT risk system for a developing country.

Figure 2 shows a qualitative model for one of the earliest risks to hit the public consciousness with the publication of Rachel Carson's book "The Silent Spring" in 1962. It is a model for a developing country of DDT. The source is DDT applied to crops as a pesticide and to homes as a public health measure against malaria. The pathways include routes through the aquatic and terrestrial food chains and also through the use of DDT containers for food and water storage.

Figure 3. Risk system for effluent from stacks and outflow pipes from an industrial plant, to illustrate the information needs and points of entry for different types of regulations.

The advantage of building such a model as illustrated in Figure 3 is that it emphasises all the steps in the causal chain that need measuring, if you are to arrive at scientifically based standards. Often it serves as a map of ignorance rather than of knowledge because for most risk systems, the data are very sparse.

One characteristic of risk models has been their increasing comprehensiveness. For example, nuclear risk analysis used to concentrate on the risks of operating the reactor. Now, the risks at the front and back ends of the fuel cycle, especially those of mining, transportation, and waste disposal, are considered to be as , if not more, important areas of risk and certainly less well quantified.

We have thus developed models of risk systems, which are increasingly complex such as those of total fuel cycles and cradle to grave models of chemicals.

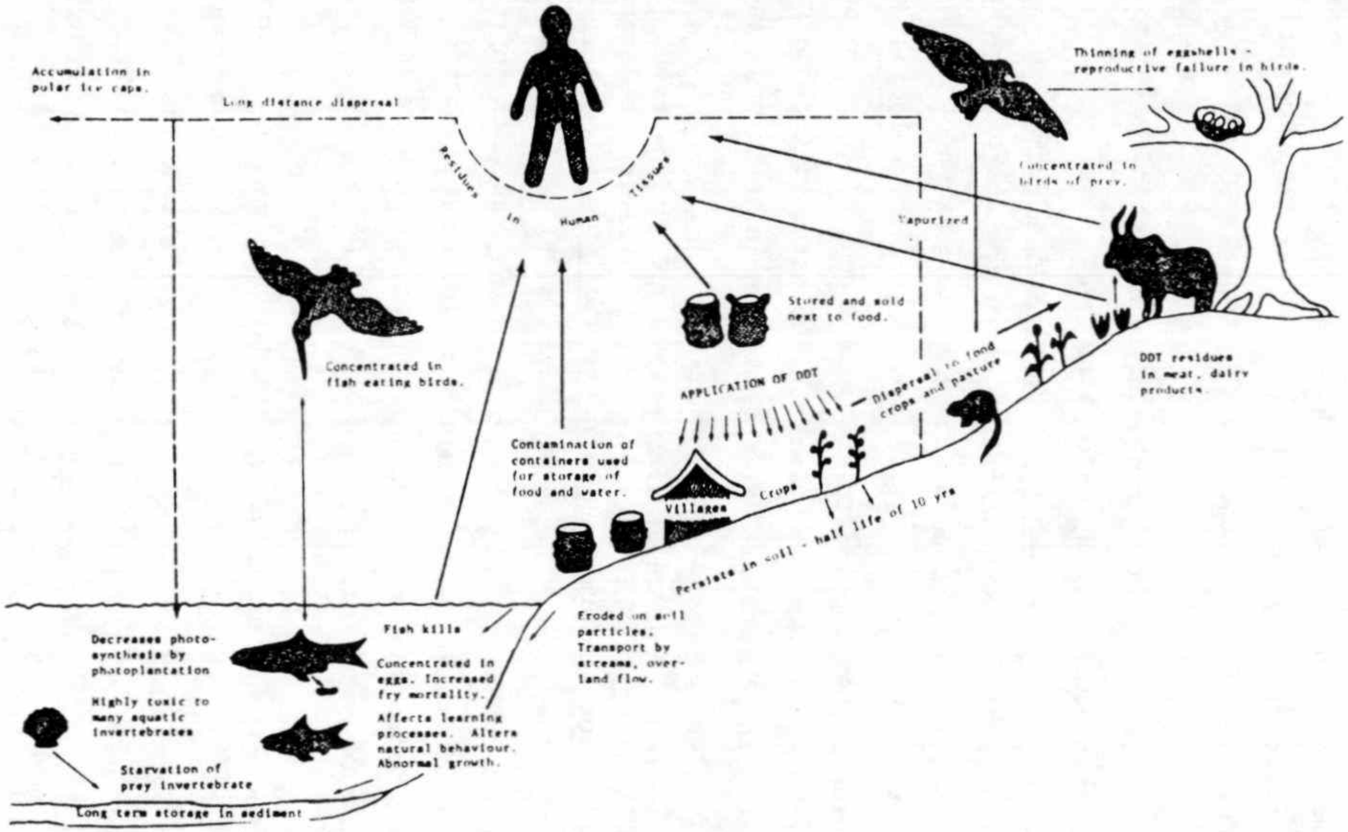


FIGURE 2. Model of DDT Risk System for a developing country (Whyte & Burton, 1980.

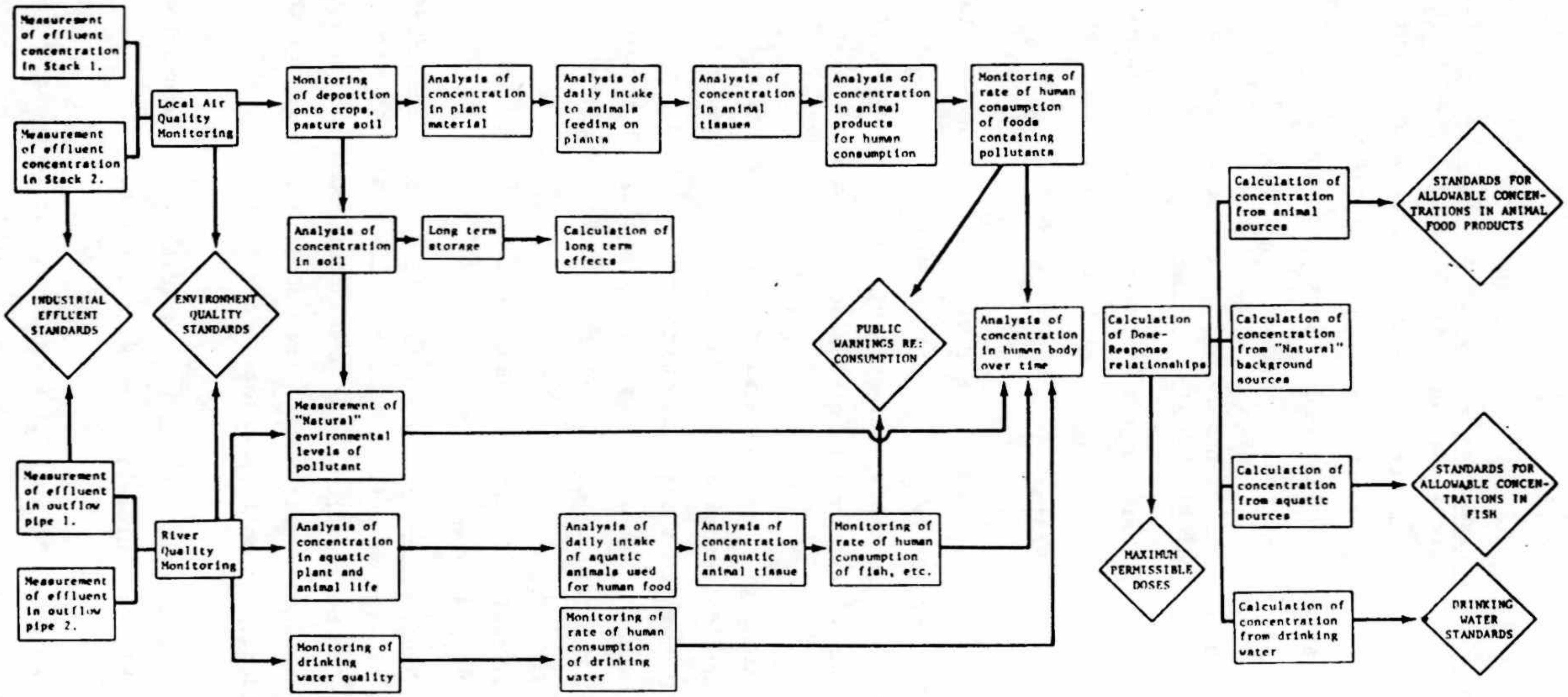


FIGURE 3. Risk system for effluent from stacks and outflow pipes from an industrial plant, to illustrate the information needs, and points of entry for different types of regulations (Whyte and Burton, 1980).

Figure 4. The imbalance of risk in a British Chemical worker's life.
(B.C. Bulloch, Reliability Engineering in the Chemical Industry).

There are some important questions to be asked about risk models, which involve value judgements on behalf of those making the models.

1) What are the smallest effects to be included?

Someone has to make a decision about what is a significant effect.

Figure 5. Hierarchy of effects on human health from premature death to minor physiological changes.

For example, there is a hierarchy of effects to human health, all the way from death (which is fairly unequivocal) to temporary emotional effects or minor physiological change (Figure 5.).

Is the anxiety caused to the Mississauga evacuees a significant effect of the derailment? So far, risk analyses for chlorine gas accidents have not included anxiety in their estimates of risk, although it appears to be one of the major social impacts of the derailment in Mississauga.

A similar problem arises with sub-clinical effects which are not detectable on physical examination. For example, in lead effects on human health, it is known that below 100 micrograms of lead per 100 ml of whole blood, clinical anaemia does not occur in adults but that there is a change in the activity of one of the enzymes in the haemoglobin chain.

Is this significant for human health? Scientists and governments disagree in their assessments.

2) What are the longest term effects to be included?

The effects of a risk, such as a chemical, may take years, or even generations to be revealed. The assessment problem lies not at the short term end of the scale, where death from drowning, or injury through an industrial accident, are both immediate, direct and unarguable effects.

Rather, the problems lie in deciding which future long-term effects are reasonable to include in a risk assessment.

For example, it is well known now that some carcinogens, such as asbestos, have long latency periods of 20-40 years between contact

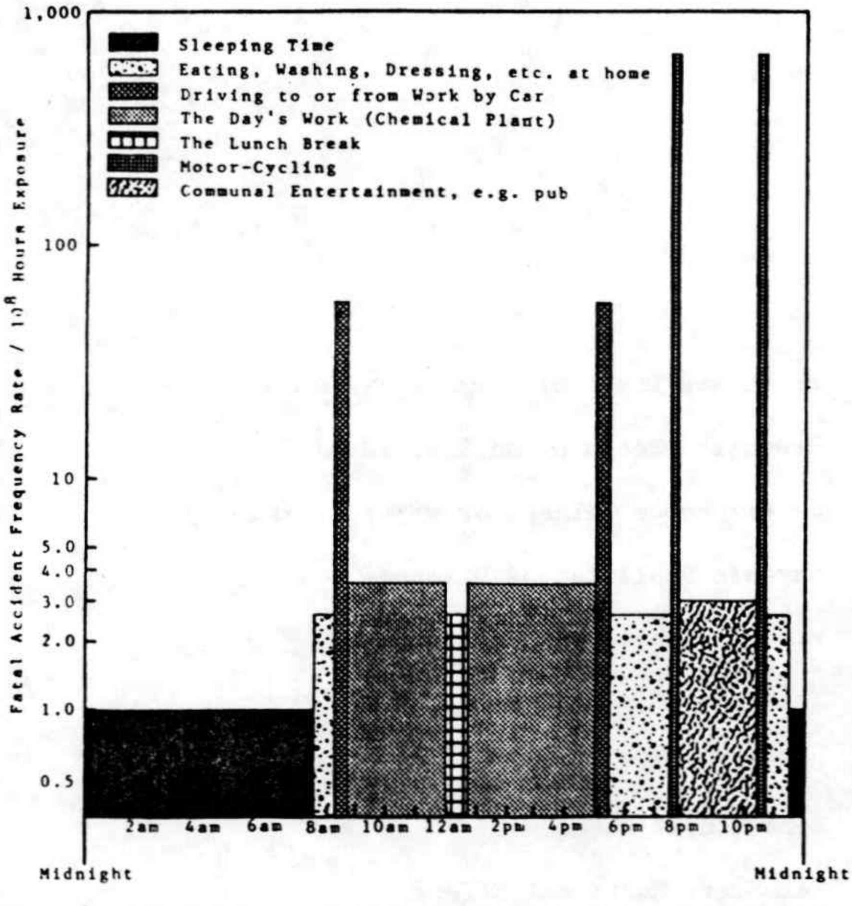


Figure 4. The imbalance of risk in a British chemical worker's life. After B. C. Bulloch, *Reliability Engineering in the Chemical Industry* (Kates, 1978).

Premature Death of Many Individuals

Premature Death of an Individual

Severe acute illness or major disability

Chronic Debilitating Disease

Minor Disability

Temporary Minor Illness

Discomfort

Behavioural Changes

Temporary Emotional Effects

Minor Physiological Change

FIGURE 5. Hierarchy of effects on human health.

with the chemical and obvious signs of its effect on human health. These latency periods are often now included in risk assessments.

But more difficult are the teratogenic (inherited birth defects) and mutagenic (adverse mutations occuring in germinal cells) risks of synthetic chemicals. These risks involve several generations and tend to lie in the realm of the hypothetical rather than the demonstrable.

As a society, Canadians have become increasingly future-oriented in their concern about risks. It is likely, therefore, that as risk assessors and waste managers, we shall more and more be dealing in the highly uncertain area of risks to Canadians yet unborn.

3) Risks to the environment

Another grey area in defining what effects of risks are to be considered risks to the environment, as distinct from risks to man.

Again, it is an area in which laymen, scientists, managers and governments differ. Some countries have legislation, for example, for controlling pesticides, which considers only their effect on human health; others include any effect on the ecosystem. Most countries lie somewhere in the middle and emphasise effects on man, animals and bees (Figure 6).

Figure 6. Harmful effects specifically considered in national pesticide legislation.

These are just three of the questions facing the risk assessor about where to make the cut-offs in the risk system - the decisions about which are influenced by, and affect, existing public policy and legislation.

The important thing in the assessment is that whatever the decisions are, they should be made explicit.

RISK ASSESSMENT AS A COMPARATIVE FRAMEWORK

The assessment process, having modelled what the risks are, and defined which effects are being included, moves to a third stage - that of providing a yardstick for measuring risks.

	HARMFUL EFFECTS ON:	COUNTRY
MAN	— human health	Finland
MAN, ANIMALS	— human health, warm blooded animals	Turkey
	— human health, bees	Austria
	— human health, domestic animals, bees	Denmark
	— human health, mammals, aquatic animals	Japan
	— human health, cattle, wildlife	Portugal
	— human health, wildlife, aquatic animals	India
	— human health, domestic animals, wildlife	UK
MAN, ANIMALS, PLANTS	— human health, domestic animals, beneficial insects, wildlife and domestic plants	Sweden
	— human health, bees, animals, plants	Switzerland
	— human health, animals, crops	Korea
MAN, ECOSYSTEM	— human health and the environment	Spain
	— human health and the environment	Netherlands
	— human health and the environment	France
	— human health and the environment	Ireland
	— human health and the ecosystem	New Zealand

Sources: OECD, 1971; Mootooka, 1977.

FIGURE 6. Harmful effects specifically considered in national pesticide legislation (Whyte and Burton, 1980).

Even where doses can be quantified - for example, 1.5 mg fluoride per litre in drinking water - any such figure lacks meaning by itself.

Risks need to be compared to something else to become relevant to decision-making.

Three commonly used yardsticks are "natural background" levels; the risks of alternatives; and the dangers of quite unrelated hazards.

Figure 7. Alternative yardsticks for comparison of risks.

Figure 8. Comparison between natural and man-made sources for low level radiation (from Aiken, Harrison and Hare, 1977).

The bases for comparison are not always in the same relative positions. Compared to the hypothetical situation in Figure 7, low level radiation leakage from nuclear reactors is less than for natural background levels or for other radiation sources such as medical therapy (Figure 8.).

These three ways of comparing risks tend either to ignore the different benefits of alternatives, or to make them equivalent for the purposes of calculation.

A fourth, and important approach, is to compare the risks with the benefits.

Figure 9. Four alternative risks equations.

These four bases for comparing risks lead to quite different 'risk equations' which we can call (Figure 9)

- elevated risk
- balanced risk
- comparative risk
- risk-benefit.

(a) Elevated Risk - Here the question asked is, what is the additional hazard over
(a) what occurs in natural environment, eg. radiation
(b) what has been tolerated for long time without apparent ill effect, eg. lead, noise
(c) what is believed to be a beneficial amount, eg. fluoride in drinking water; trace amounts of some heavy metals.

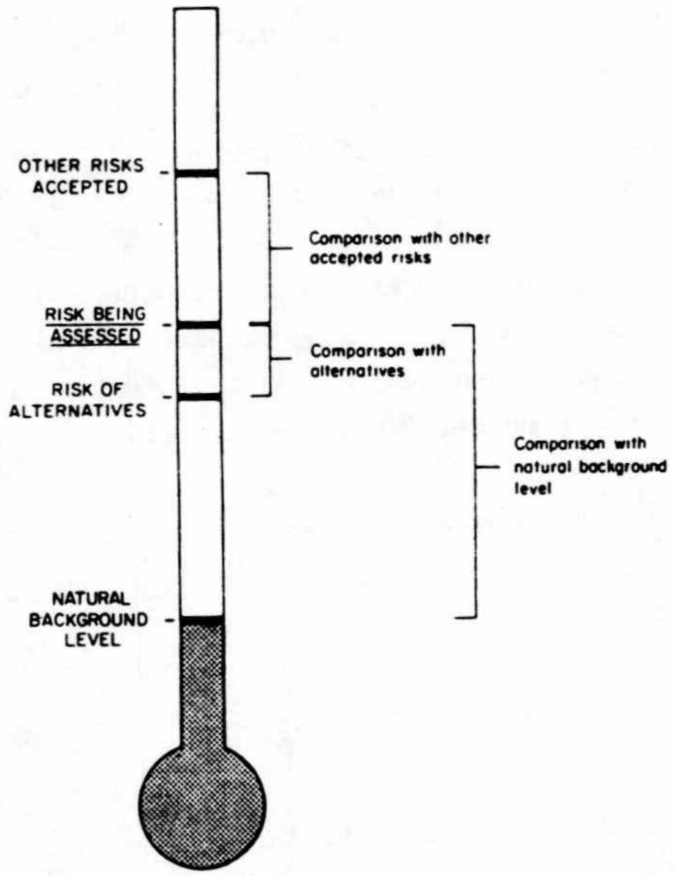


FIGURE 7. Alternative yardsticks for measuring risk (Whyte and Burton, 1980).

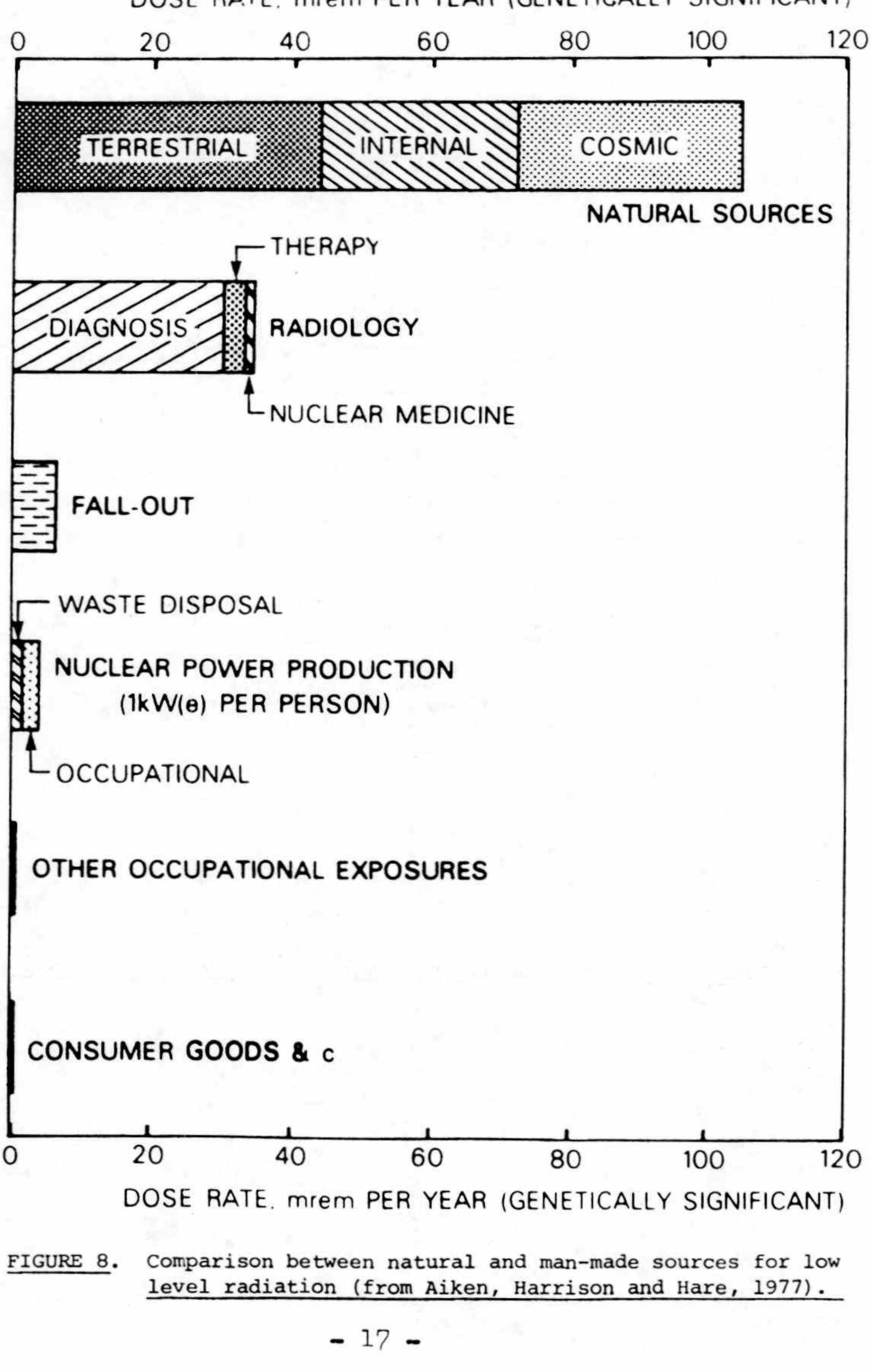


FIGURE 8. Comparison between natural and man-made sources for low level radiation (from Aiken, Harrison and Hare, 1977).

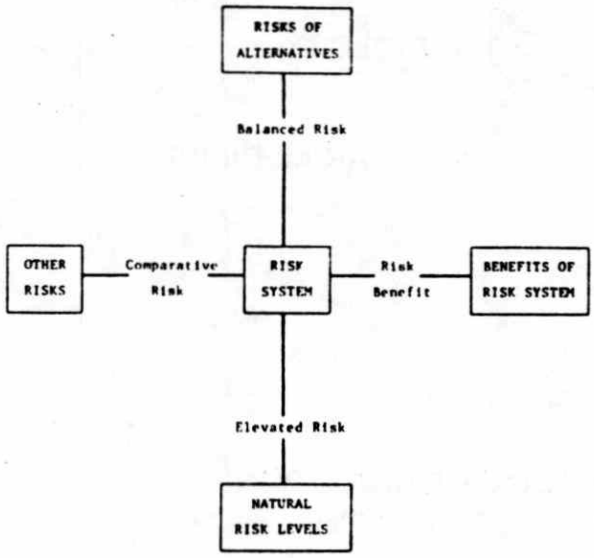


FIGURE 9. Four alternative risk equations (Whyte and Burton, 1980)

(b) Balanced Risk

Another way to make a risk level meaningful is to ask what alternatives there are. For example, comparing the risks of one pesticide to another, or comparing the risks of asbestos insulation to fibreglass.

The idea is to arrive at a combination which results in the lowest aggregate risk. Its limitation is that, in practice, it is difficult to consider alternatives merely in terms of risks, as their benefits rarely are so equivalent that they can be excluded.

The assessor is therefore usually weighing risks versus benefits for each alternative.

(c) Comparative Risk

A common yardstick for measuring the significance or the acceptability of a risk is to compare it with other risks.

In this kind of analysis, the consequences are reduced to a common denominator - usually death - and the benefits are ignored.

This is because the benefits cannot strictly be compared. The risks being compared are in no way alternatives.

They are simply being compared on an actuarial basis of their probability of causing death.

Figure 10. Deaths per billion with one hour of exposure to risk (Stannard, 1969).

The commonest risks used for comparison are smoking and traffic accidents because they are well recognised and relatively high. Figure 10 indicates that if you can survive being born, other risks are low by comparison.

Comparing the risks from a landfill site to those of crossing the road may be useful for public relations (though this is doubtful) but they are not very useful for regulatory decisions.

	Deaths per billion persons with one hour risk exposure
Being vaccinated or inoculated	1.3
Exposure to radiation in a two hour high altitude flight during solar flare	2.5
Living in area where snakes are present	3.8
Radiation exposure of world population in major nuclear war (areas away from conflict)	5.0
Railroad or bus travel (USA)	10.0
(Britain)	50.0
Child asleep in crib	140.00
Being struck by lightning	200.0
Coal mining (Br.)	400.0
Amateur boxing (Br.)	450.0
Climbing stairs	550.0
Coal mining (USA)	910.0
Hunting	950.0
Automobile travel	1200.0
Air travel	1450.0
Cigarette smoking	2600.0
Mountain climbing (USA)	2700.0
Boating (small boats)	3000.0
Motor scooter riding (Br.)	3000.0
Swimming	3650.0
Motor cycle riding (Canada)	4420.0
(USA)	6280.0
(Br.)	6600.0
Armed forces in Viet Nam	7935.0
Canoeing	10000.0
Motor cycle racing (Br.)	35000.0
Mountain climbing (Alpine)	40000.0
Professional boxing	70000.0
Being born	80000.0

FIGURE 10. Deaths per billion with one hour of exposure to risk (Stannard, 1969).

If you compare a more closely defined set of risks, however, the comparisons can be more practical. For example, occupational risks are frequently compared in this way. By showing how much money is spent to prevent deaths, a comparison of the probability of death between different occupations can give a measure of the implicit value that is put on human life (Figure 11).

Figure 11. Life valuations for different occupations in the UK derived from risk levels set by current control techniques (Sinclair, Marstrand and Newick, 1972).

Occupation	Annual Risk of Death	Implicity Valuation of Life (£ sterling in 1972)
Trawling	1.4 in 1,000	negative value
Agriculture	2.0 in 10,000	£ 10,000
Steel handling	2.2 in 10,000	£ 230,000
Nuclear Energy		£ 1,000,000
Pharmaceuticals	2.0 in 100,000	£10,500,000

A fourth way to comapre risks is to compare them with the benefits they bring. By this argument, greater risks can be accepted where there are greater benefits.

Similarly, higher wages are set against higher risks in some occupations (Figure 12).

Figure 12. Mining accident rates in USA versus hourly wage (Starr, 1972).

Figure 13. Alternative risk equations and their relation to legislative concepts.

I would like to come back to the four basic ways in which risks are compared to indicate how these comparisons are related to concepts used in legislation (Figure 13).

The concept of reasonableness is very important to risk assessment in Canada, and in other countries influenced by the English Common Law system. Ultimately, risk assessments in Canada are all evaluated in the light of what is reasonable.

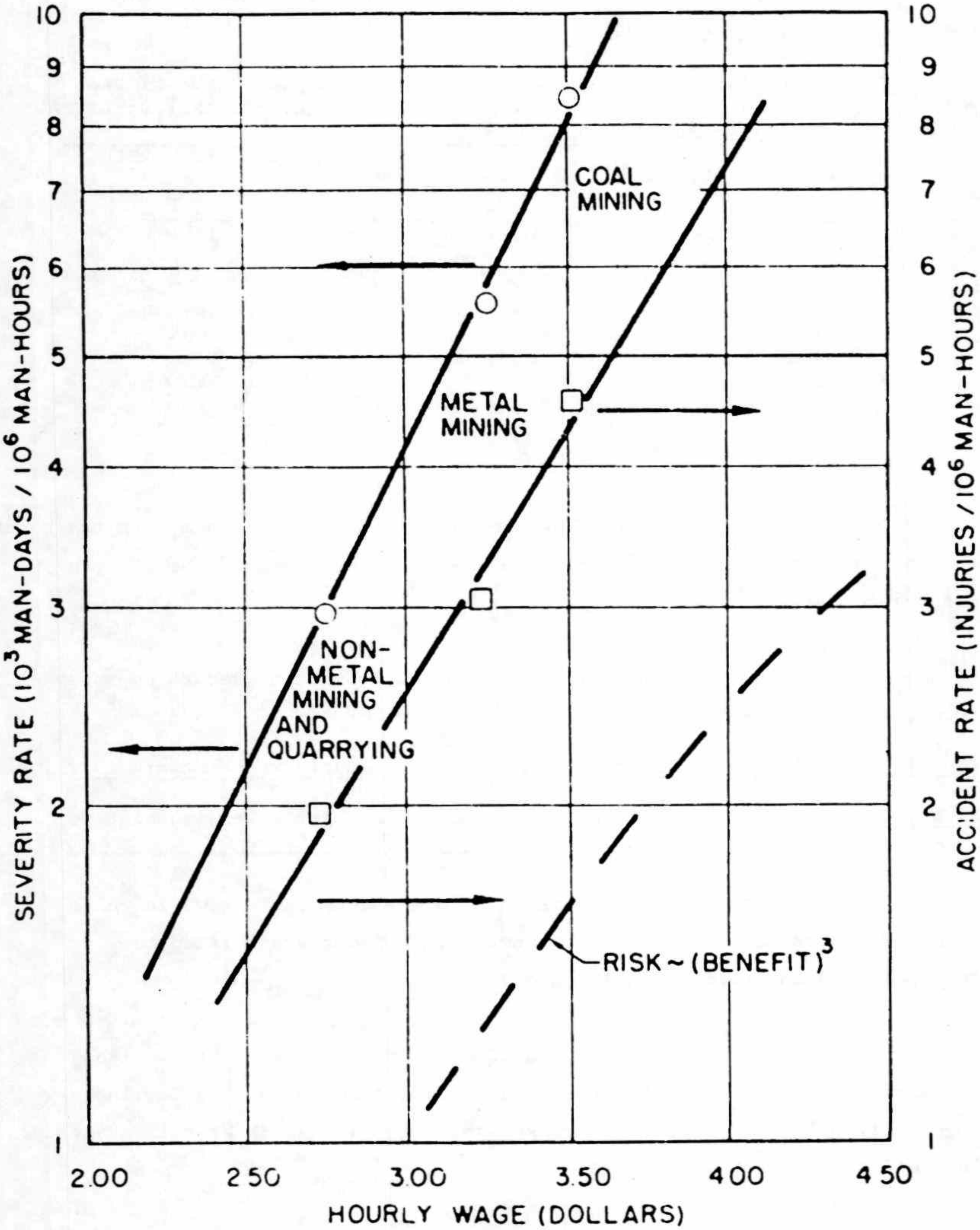


FIGURE 12. Mining accident rates in USA versus hourly wage (Starr, 1972).

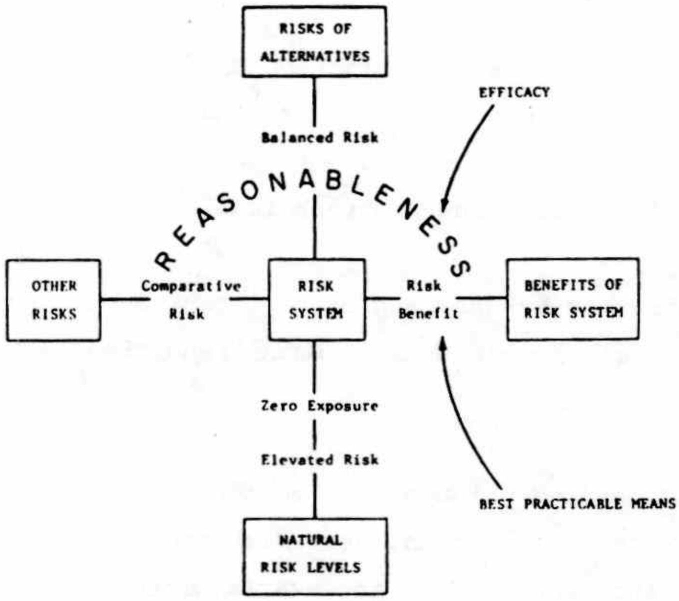


FIGURE 13. Alternative risk equations and their relation to legislative concepts.

Reasonableness is legally defined as that which is "in the scale of foresight of the reasonable man" (Harper and James, 1956).

While this may seem a circular argument, the motions of 'ordinary', 'average', and 'natural' for measuring risks are well established in our legislation. They come closer to the notion of acceptable risk than to 'zero risk'.

Similarly, "best practical means" - a phrase much used in Canadian legislation - can be defined as that which is "reasonably practicable, having regard to local conditions and circumstances, including financial implications and technical knowledge".

This case-by-case approach to risk assessment, which is implicit in the use of "best practical means" and "reasonableness" is very different from "zero risk".

The guiding principle of zero risk is that no level of risk is acceptable. Taken as it stands, zero risk does not require other factors - such as the benefits, or the availability of alternatives to be taken into account.

Zero risk puts the emphasis on the risk side of the quation.

Zero risk has been most discussed in the assessment of risks from suspected carcinogens. In the USA, it is most closely associated with the well-known Delaney Clause relating to food and colour additives. It was used to ban the sweetener cyclamates in 1969 and to try to ban saccharin in 1977.

One difficult with a zero risk, or zero exposure, approach in legislation is that the definition of zero depends on how well you can measure it. Legally, it means that no risk can be permitted, but technically it means that no risk can be detected.

When techniques for measuring residues of contaminants improved by several orders of magnitude, during the 1960's in the USA, previously 'uncontaminated' material was suddenly declared contaminated by somewhat embarrassed regulators.

Today's analytical techniques are almost 1 million times more sensitive than they were in 1958. For example, in 1958, 50 parts per million was regarded as the practical equivalent of zero. Today, electron microscopes, mass spectroscopy, neutron activation analysis and gas chromatography can together detect contaminants in amounts as little as one part in one trillion (10^{-12}).

And for tomorrow, who knows?

A second argument against zero risk is that our technical ability to detect 1 part in 1 trillion far outstrips our ability to evaluate the significance of such minute amounts.

The principle of zero risk lies in the model of the dose-effect relationship it is based on.

Figure 14. Dose-effect relationships.

Figure 14 shows the different kinds of relationships that can exist between the dose of, or exposure to, a risk and the effect or response it produces. The two relationships most discussed are

A. Threshold relationships

B. Zero threshold relationships.

Threshold relationships are those where there is no risk (Curve 1) or low risk (Curve 2) until a certain level of exposure takes place. Sometimes the effects of exposure are impossible to separate from similar effects which occur without exposure (Curve 3).

Zero threshold relationships asusme that zero risk occurs only at zero exposure. The relationship may be straight line through the origin (Curve 5) or may show increasing (Curve 6) or decreasing (Curve 7) sensitivities at higher doses.

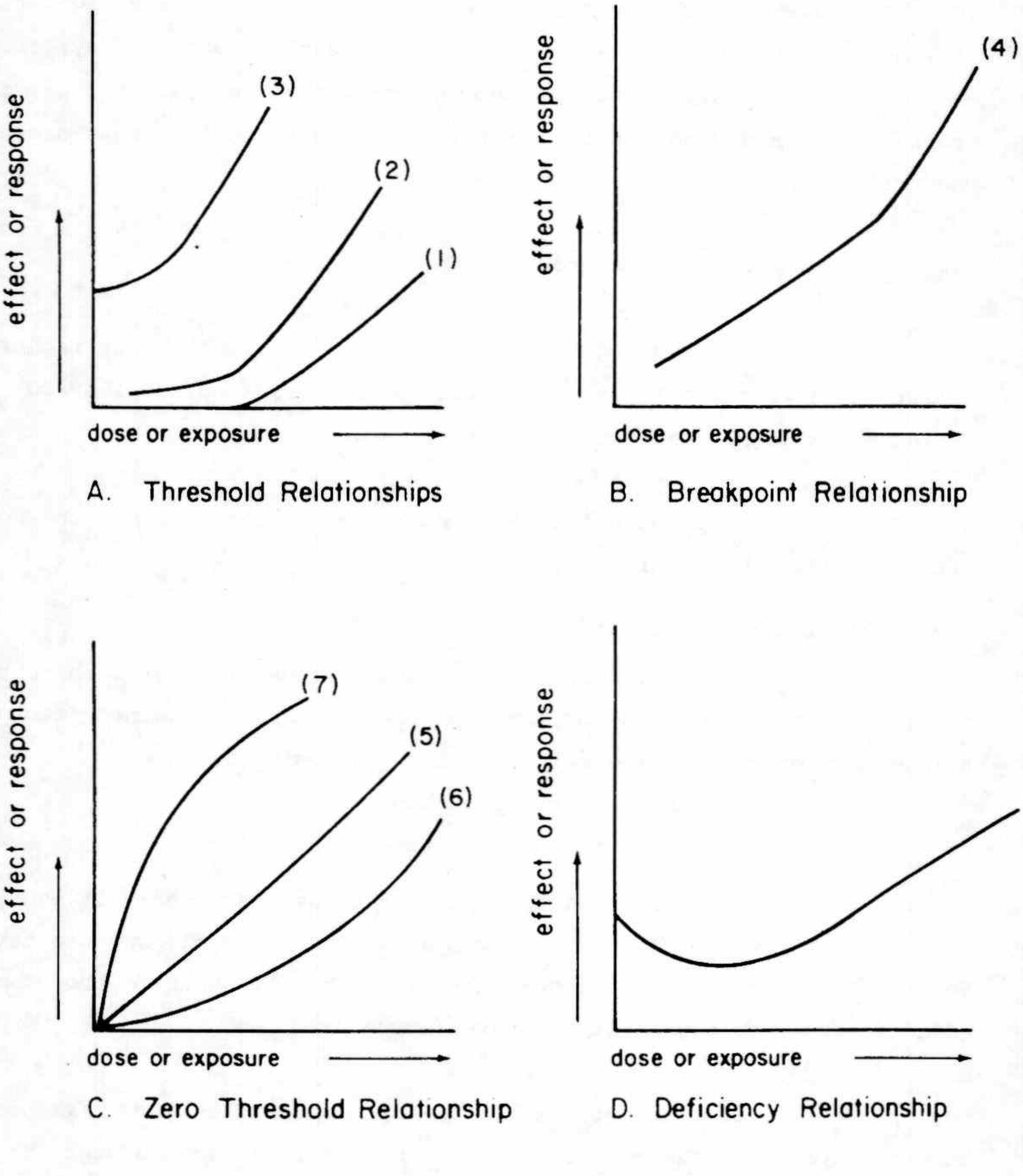


FIGURE 14. Dose-effect relationships.

RISK PERCEPTION

Probability and consequence lie at the heart of the risk analysis process. However, thinking about risk as it applies to yourself as an individual, or to your immediate family, is quite a different matter from risk analysis.

Figure 15. Differences between scientific and public assessments of risk.

When we contemplate risks, as members of the public, we focus mainly on the drama of the consequences; we worry about the possible causes that might lead to such consequences; and we don't think very much about their probabilities.

These are important differences between risk analysis and risk perception which both have to be taken account of in RISK ASSESSMENT.

Figure 16. Comparison of perceived risk with actual risk (Starr and Whipple, 1980.

If we compare perception of risk with actual probabilities of death from different causes, data for the USA indicates that people overestimate low probability risks, eg. tornado, and underestimate high probability risks, eg. heart disease. That is, in risk perception the scale of probability is shrunk from 1 to 1 in million
to 1 to 1 in 100,000.

The characteristics of the risk also influence how it is perceived. Some characteristics, such as the voluntary nature of a risk or delayed effects tend to minimise public concern while other characteristics, such as many fatalities at one time or place tend to increase public concern.

Figure 17. Factors in public risk perception.

These factors can be used to illustrate qualitatively whether a risk is likely to be perceived as of great concern or not to the public. For example, in Figure 18, nuclear power is compared to smoking and it can be seen that smoking has more characteristics that tend to reduce public concern.

SCIENTIFIC VIEW	RISK = PROBABILITY X CONSEQUENCES
PUBLIC PERCEPTION	RISK = CONSEQUENCES^{P} X CAUSE X *probability*

FIGURE 15. Differences between scientific and public assessment or risk

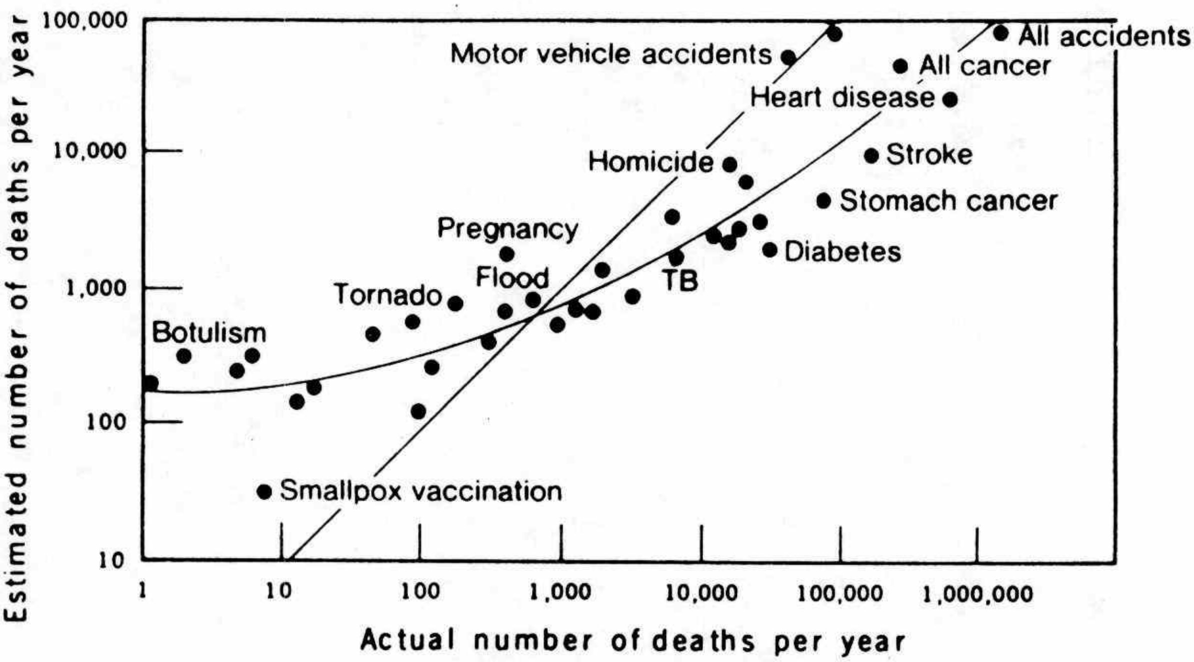


FIGURE 16. Comparison of perceived risk with actual risk (Starr and Whipple, 1980).

HIGHER RISK	LOWER RISK
INVOLUNTARY	VOLUNTARY
'DREAD' HAZARDS	COMMON HAZARDS
CHILDREN AT RISK	NO CHILDREN
IMMEDIATE	DELAYED
LARGER NUMBER OF SIMULTANEOUS FATALITIES	SMALL NUMBER OF SIMULTANEOUS FATALITIES
BUNCHED OR GROUPED FATALITIES	SCATTERED OR RANDOM FATALITIES
MECHANISMS OR PROCESS NOT UNDERSTOOD	PROCESS UNDERSTOOD
NOT EXPERIENCED	FAMILIAR
UNCONTROLLABLE	CONTROLLABLE
IDENTIFIABLE VICTIMS	STATISTICAL VICTIMS

FIGURE 17. Factors in public risk perception

Figure 18. Perception of nuclear power vs smoking as loaded on various factors (qualitative data only).

Accidents play an important role in increasing public awareness of risks.

Figure 19. Public concern about the transportation of hazardous goods by rail before and after the Mississauga derailment.

For example, before the Mississauga derailment of November, 1979, most people both in Mississauga and in the matched group in Don Mills, were unaware of the hazardous goods being transported through their neighbourhoods. After the emergency, people in both groups expressed much greater concern about the risks, especially those in Mississauga who had experienced the evacuation (Figure 19).

CONCLUSION

Interestingly enough, the accident at Three Mile Island Nuclear Reactor did not increase public opposition to nuclear power generation in Canada but it did dramatically raise opposition to construction of a nuclear power plant in a person's home area.

Perception, or concern, about risks is a function of awareness, knowledge and attitude.

The Canadian public's knowledge about the technical, scientific and medical aspects of hazards falls far short of their awareness.

For example, in Atlantic Canada, 30% of the public were aware of acid rain in 1979. By October 1980, through news reports, 70% in Atlantic Canada and 65% in Canada as a whole, had heard of the problem. Today, it is the number one environmental issue for people in Ontario. However, only 10% of Canadians know what acid rain is (Gallup Report, October 15, 1980).

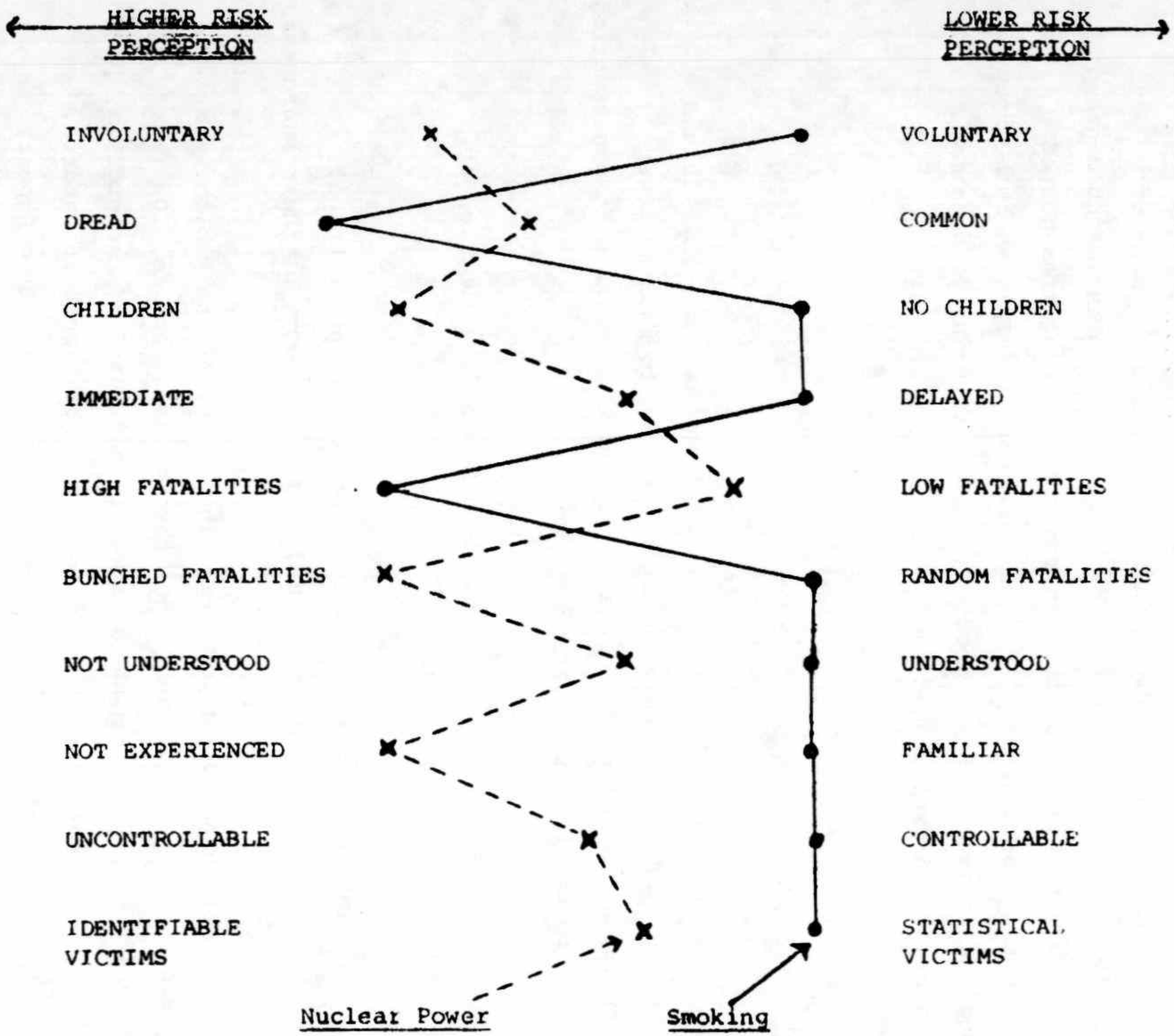


FIGURE 18. Perception of nuclear power vs smoking as loaded on various factors (qualitative data only).

	MISSISSAUGA EVACUEES	DON MILLS CONTROL GROUP
	N = 502	N = 200
BEFORE ACCIDENT	PER CENT	PER CENT
VERY CONCERNED	7	1
CONCERNED	18	9
NOT CONCERNED	8	17
UNAWARE	67	73
AFTER ACCIDENT		
VERY CONCERNED	44	26
CONCERNED	40	56
NOT CONERNED	14	17
UNAWARE	0	0

FIGURE 19. Public concern about the transportation of hazardous goods by rail before and after the Mississauga derailment.

Risk assessment involves a search for a 'best route' between social benefit and risk. It is a balancing or trading-off process in which various combinations of risks are compared against particular social and economic gains. It is a process in which the findings of risk analysis have to be melded with the concerns of risk perceptions and the acceptability of risks.

Risk assessment does not necessarily imply a zero-risk policy or even a minimum risk one. What it encourages us to do is to understand the risks as fully as possible in order to best manage them; to identify the gaps both in knowledge and in regulation; and to make explicit the value judgements involved.

Risk assessment pre-supposes that a new species of manager is emerging - the risk assessor - who has, in a world of increasing specialisation, to understand and bring together the scientific, medical, legal, policy, management and public relations aspects of risks. The role is a difficult and often contradictory one.

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LIST OF FIGURES

Approach to Risk Assessment

by

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<u>Note:</u> The text of Dr. Kim's paper was not made available by the author for inclusion in these Proceedings.

ENVIRONMENTAL HEALTH PROTECTION IN CANADA
- APPROACHES TO HAZARD AND RISK ASSESSMENT

by

George C. Becking

Environmental Health Directorate
Health Protection Branch
National Health and Welfare

I. Introduction

I believe a few words of explanation are in order regarding the change in title of my paper. Although I maintain a very close liaison with the toxicologists and clinicians within the Ontario Government, I felt it rather presumptious of me to speak in detail on the Ontario approach to risk assessment. It is my understanding that the approaches used within the Department of National Health and Welfare, which I will discuss, are in fact very similar to those used in Ontario, but I am sure there are differences in interpretation and evaluation of available data, which will lead to apparent differences. There may well be differences in the level of risk accepted within the two jurisdictions, but that is a socio-economic, political decision, not part of my discussion.

Environmental health, in the most general sense, covers all threats to human health from exogenous factors such as physical and chemical agents, as well as lifestyle (e.g. diet, smoking, alcohol, sunbathing, etc.). Man, at various times of his life, is exposed to many of these factors simultaneously. The assessment of the potential risk from such a mixture of real and potential hazards is one of the major issues now facing governments. Society can deal with such hazards in at least four basic ways:

economic, educational, socio-cultural, and regulatory. My paper will deal with one aspect of this latter mechanism, that is, the use of risk assessment in environmental health regulatory strategies.

II. Procedures for Risk Assessment

There are several steps in carrying out a risk assessment, each one requiring a certain scientific expertise. The major steps are: (i) collection of toxicity <u>and</u> exposure data, (ii) evaluation of the quantity and quality of data, (iii) determination of hazard potential, and (iv) calculation of potential risk. The need for adequate evaluation of data by experts at all steps cannot be overemphasized too strongly.

Risk assessment is an intuitive process carried out by appropriately trained professionals, knowing the uncertainties involved during each step of the process. Given the "state-of-the-art" of the biological sciences, particularly toxicology, no standardized format (cookbook) can be developed. Every chemical, or mixture of chemicals, is a distinct problem. The exact procedure to follow, or model used, will depend on the quantity and quality of data, the toxic end point of concern and the length of man's exposure (acute vs chronic). Ideally, one would like

to have data available as shown in Table I. In Table II, an idealistic procedure for carrying out risk assessments is presented.

Traditionally, two approaches have been taken to estimate risks from chronic exposures to environmental chemicals (including contaminants in food). For reversible toxic effects (non-carcinogenic and non-mutagenic), one can use the "Acceptable Daily Intake" (ADI) approach, long used in the food additive area, and calculate a tolerable daily intake for a chemical, that is, the dose that is anticipated to be without lifetime risk to humans when taken daily. Provided high quality dose response data on chronic effects and other biological factors (metabolism, absorption, etc.) are available, this technique poses little problem. Safety factors between 100 and 500 have been used to extrapolate from animal data depending on the toxic endpoint and the quality of data, whereas a safety factor of 10 appears adequate when suitable human data are available.

Although discussed as a risk assessment methodology, I believe a short quote from a National Academy Publication (1) is in order: "It should be cautioned that even when complete toxicological data are available, . . . the ADI represents only a judgement regarding acceptable levels of human exposure and is not an estimate of risk, nor a

guarantee of absolute safety". In other words, the probability of a hazard occurring in a certain proportion of a population is not actually determined.

The assessment of human risk from animal carcinogenicity data is a major dilemma in the area of regulatory toxicology. This problem has developed, in part, from ignorance of the biology of carcinogenesis, the uncertainty of the relevance of other biological findings to the risk assessment process, as well as the too vigorous application of mathematics to as yet unknown biological mechanisms. It has become extremely convenient for the toxicologist to agree with the non-threshold hypothesis, thus shirking the responsibility for scientific evaluation of all available data. "Mathematical models will determine the level of risk" has become a common decision; whether all such assessments are biologically meaningful remains uncertain.

If one does not blindly hold to the threshold concept and attempts to scientifically evaluate all available data, the conclusion will be made that no one model will be useful for all chemicals. The shape of the dose response curve will vary (Figures 1 and 2), negating the usefulness of certain models, the chemical may or may not affect the genetic material (genotoxic) and the effects of excessively high doses on normal body functions are just a few of the scientific facts which will determine the appropriate model

for assessing the risk from potential carcinogens. Mathematical models cannot deal with such problems, but well qualified toxicologists can. I am sure it is obvious from Figures 1 and 2 that these two compounds are biologically quite distinct and require a different approach when assessing potential risk. A summary of the biological factors which will influence the choice of model for use in any risk assessment for carcinogens is presented in Table III. As we discuss specific examples, the importance of these factors should become more evident, as will the need for more than one rigid model.

It should not be concluded from this discussion that statistical procedures for risk assessment are of <u>no</u> value to regulators. At present, they <u>cannot</u> be used in isolation to establish estimates of risk for humans. There is a definite place in regulatory toxicology for such procedures, provided all relevant biological data are taken into account when choosing and using these models. As a statistician colleague of mine recently stated, "Mathematics is no substitute for common sense". Also, "the addition of a number to a 'guess' does not make it a fact".

III. Examples of Risk Assessment

I would like to present some specific examples of risk assessments carried out within the Environmental Health

Directorate, National Health and Welfare, which will illustrate the various procedures used.

(a) <u>Nitrilotriacetic Acid (NTA)</u>

The detergent builder NTA is widely used in Canada (>50 x 10^6 lbs/year); most being disposed of in sewage, leading to trace levels in some drinking water supplies. The extensive data package available is summarized in Table IV. NTA exhibits low chronic toxicity, except when fed at exceedingly high doses (when it produces an increased incidence of urinary tract tumors in rodents). No evidence of teratogenic or mutagenic activity has been noted (2), and the physiological effects of high doses of NTA are becoming clearer (3). The shape of the dose response curve (Figure 1) and the lack of mutagenic activity does not support the use of non-threshold linear models for risk assessment. As shown in Table V, even the use of non-threshold models indicates an extremely low risk from the presence of NTA in drinking water. If one concludes that a threshold exists and uses a safety margin of 100, a 70 kg human could ingest drinking water containing 5 mg NTA/L without undue risk. For prudence, this procedures was not used in setting the drinking water guideline of 50 μg/L.

(b) Trihalomethanes (Chloroform)

Trihalomethanes (THM) are known to occur in drinking waters treated with chlorine. In Canada, levels of THM's between 0 and 121 µg/L have been found (4). The most common TH M is chloroform, and only for this chemical does an adequate data package exist which would allow one to carry out any sort of risk assessment. As shown when Table I and Table IV and compared, we are dealing with a less than ideal data package. Very little non-carcinogenic chronic toxicity tests have been carried out, only minimal mutagenicity data are available (negative Ames), but the intraspecies metabolism and pharmacodynamics have been reasonably well studied. In addition, human epidemiological data are available. Although the shape of the dose response curve and other data indicate a non-genotoxic carcinogen, inadequacies in the data package and the equivocal epidemiological findings supported the conclusion to use statistical models for the estimation of risk from chloroform in drinking water.

As seen in Table VII, depending on the model chosen, the risks will vary from $<1 \times 10^{-9}$/lifetime to 0.4×10^{-6}/yr when consuming 0.01 mg/kg (350 µg/L for 70 kg man). It was on the basis of such an

assessment that the Canadian Drinking Water Guideline of 350 μg/L was published.

(c) Water-Borne Asbestos

The carcinogenic properties of air-borne asbestos fibres have been well documented in humans and animals (Table VIII). An assessment of risk to humans has led to restrictions on the number of fibres in the workplace (Federal standard presently 2 fibres/cc under review) and for outdoor emissions, as well as the banning of asbestos in children's toys and modelling clays.

There are large gaps in the data base regarding the biological effects of water-borne asbestos fibres. Some of the pieces of information will soon be available, but there are presently insufficient data upon which to base a quantitative risk assessment. The available epidemiological studies on the association of asbestos fibres in water to increased cancer rates have been negative. Given the lack of animal data and negative epidemiological findings, a drinking water guideline for asbestos fibres cannot be scientifically supported.

An ambient water quality criteria for asbestos has been proposed by EPA (6) using inhalation exposure data from occupational studies and various

assumptions on the number of fibres ingested after pulmonary clearance. Although they have arrived at a risk estimate of 1×10^{-6} for 30,000 fibres/L, this value must be thoroughly reviewed. The assumptions used to arrive at such an estimate of risk are not necessarily biologically valid.

Three different types of risk assessments have been discussed. There is insufficient time to deal similarly with several other risk assessments carried out by National Health and Welfare in the field of environmental health. These are listed in Table IX. The quantity and quality of data available for these assessments varied greatly. For the assessment of risk from radioactivity, extensive human and animal data exists which support the use of a statistical procedure. Also, the epidemiological studies in Canada, as well as those worldwide, are the cornerstone supporting an assessment of negligible risk from present day water fluoridation practices (maintenance of 1 - 1.2 mg F/L).

IV Conclusion

By presenting this overview of certain risk assessments carried out by the Department of National Health and Welfare, I hope I have given the reader some insight into the problems

involved in carrying out such studies (from the collection and evaluation of data to the use of models). It is one of the major tools in providing adequate environmental health protection, and therefore must rest on good scientific principles. This latter statement implies that available data must be of high quality and evaluated by appropriately trained scientists. All biological data must be evaluated and utilized when necessary in concert with mathematical models, to arrive at an estimate of human risk which has any degree of certainty.

IV. References

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(2) International Joint Commission (IJC) Task Force Report - Health Implications of NTA, 1978.

(3) R.L. Anderson and R.L. Kanerva. Fd. Cosmet. Toxicol. 16: 563 and 569, 1978.

(4) Canada, Department of National Health and Welfare. Document No. 77-EHD-9. Ottawa, 1977.

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(6) Environmental Protection Agency, Ambient Water Quality Criteria for Asbestos. No. 440/5-80-022. October 1980.

Table I

OPTIMAL INFORMATION FOR HEALTH HAZARD OR RISK ASSESSMENTS*

General	- Physico-Chemical Properties (Structure)
	- Environmental Fate
	- Monitoring Data
	- Use and/or Production
Toxicology	- General Acute and Chronic Toxicity
	- Pharmacokinetics/Metabolism
	- Teratogenicity/Reproduction
	- Mutagenicity
	- Carcinogenicity
	- Effects of High Doses (Biochemical and Physiological)
	- Neurotoxicity and Behaviour
	- Immunological Effects

* Risk assessments are usually carried out with much less information - BUT - any assessment becomes more tenuous as pieces of information are omitted.

Table II

IDEAL PROCEDURE FOR ASSESSMENT OF RISK

1. Identify Toxicological End-Point of Concern
2. Estimate Exposure, Population at Risk and Calculate Total Daily Intake
3. Evaluate Variety and Validity of Data
4. Collect Data in Deficient Areas
5. Calculate Maximum Potential Risk
   (a) Threshold Models
   (b) Non-threshold Models
6. Acceptable Risk (non-scientific, societal concern)
7. Utilization of Epidemiological Data

Table III

BIOLOGICAL FACTORS INFLUENCING CHOICE OF MODELS FOR RISK ASSESSMENT

1. Number of Species and Strains Affects
2. Number of Tissue Sites At Which Tumors Occur
3. Latency Period
4. Dose Level Required to Induce Tumors
5. Nature and Severity of Other Pathological (and Physiological) Changes
6. Metabolic and Pharmacokinetic Data
7. Biochemical Reactivity (DNA, RNA and Protein)
8. Mutagenic Activity

Table IV

DATA AVAILABLE FOR ASSESSMENT OF RISK FROM NITRILOTRIACETIC ACID (NTA)

1. Physico-Chemical, Environmental Fate and Speciation
2. Environmental Monitoring
3. Acute and Chronic Toxicity
4. Pharmacokinetics - Metabolism - Tissue Distribution
5. Biochemical and Physiological Effects of High Doses
6. Teratology - Reproduction
7. Mutagenicity
8. Carcinogenicity (Dose Response)

Table V

ASSESSMENT OF RISKS FROM
ENVIRONMENTAL LEVELS OF NTA*

Total Daily Intake -- 0 - 0.6 μg/kg
(Av - 0.1 μg/kg)

Physiological Dose - <0.07 μg/kg

Toxic End-Point	Model	Risk
Kidney Damage	Safety Factor (100)	Non-Detectable at 150 μg/kg
Urinary Tract Cancer**	(a) Linear "one-hit"	$<2 \times 10^{-7}$
	(b) Weibull	$<1 \times 10^{-6}$ at 200 mg/kg

* Toxicology carried out on Na_3NTA or H_3NTA, not less toxic CaNaNTA species in the environment.

** Non-threshold models used although NTA is not a genotoxic, direct acting carcinogen.

Table VI

DATA AVAILABLE FOR DETERMINATION OF POTENTIAL RISK FROM TRIHALOMETHANES IN DRINKING WATER*

1. Chemical Properties - Environmental Monitoring
2. Acute-Subacute Toxicity
3. Chronic Toxicity $\pm$ (Human?)
4. Metabolism Studies
5. Mutagenicity and Carcinogenicity
6. Epidemiology

* Major Trihalomethanes are: chloroform, bromodichloromethane, chlorodibromoethane and bromoform. Data for risk assessment available only for chloroform.

Table VII

MAXIMUM RISK FROM CHLOROFORM INGESTION*

Model Chosen	End Point**	Estimated Maximum Risk
Probit-Log (Slope = 1)	Kidney Cancer	0.016-0.04/Million/yr
Probit-Log (Actual Slope)	Kidney Cancer	<1/Billion/Lifetime
Linear (one-hit)	Kidney Cancer	0.42/Million/yr
Two-step	Kidney Cancer	0.28/Million/yr

* Dose assumed to be 0.01 mg/kg/day. That is, consumption by a 70 kg man of 2L of water containing 350 ug Chloroform/L.

** Rat assumed to be closer to man than mouse.

Source: R.G. Tardiff, JAWWA 69:658, 1977

Table VIII

DATA AVAILABLE FOR ASSESSMENT OF RISK FROM WATER-BORNE ASBESTOS

1. Physical and Chemical Properties (air vs water?)
2. Environmental Monitoring
3. Animal Studies

Air-borne	Water-borne
Acute to Chronic	Pharmacokinetics
Carcinogenicity	Carcinogenicity (?)
Pharmacokinetics	Epidemiology
Effects of High Doses	
Epidemiology	
Interactions	

Table IX

ADDITIONAL ENVIRONMENTAL HEALTH RISK ASSESSMENTS CARRIED OUT BY DEPARTMENT OF NATIONAL HEALTH AND WELFARE
1. Water Fluoridation
2. Nitrosamines
3. TRIS [Tris(2,3-dibromopropyl phosphate)]
4. Radioactivity in Drinking Water

Dose Response Curve for NTA Induced Kidney Tumors in Rats

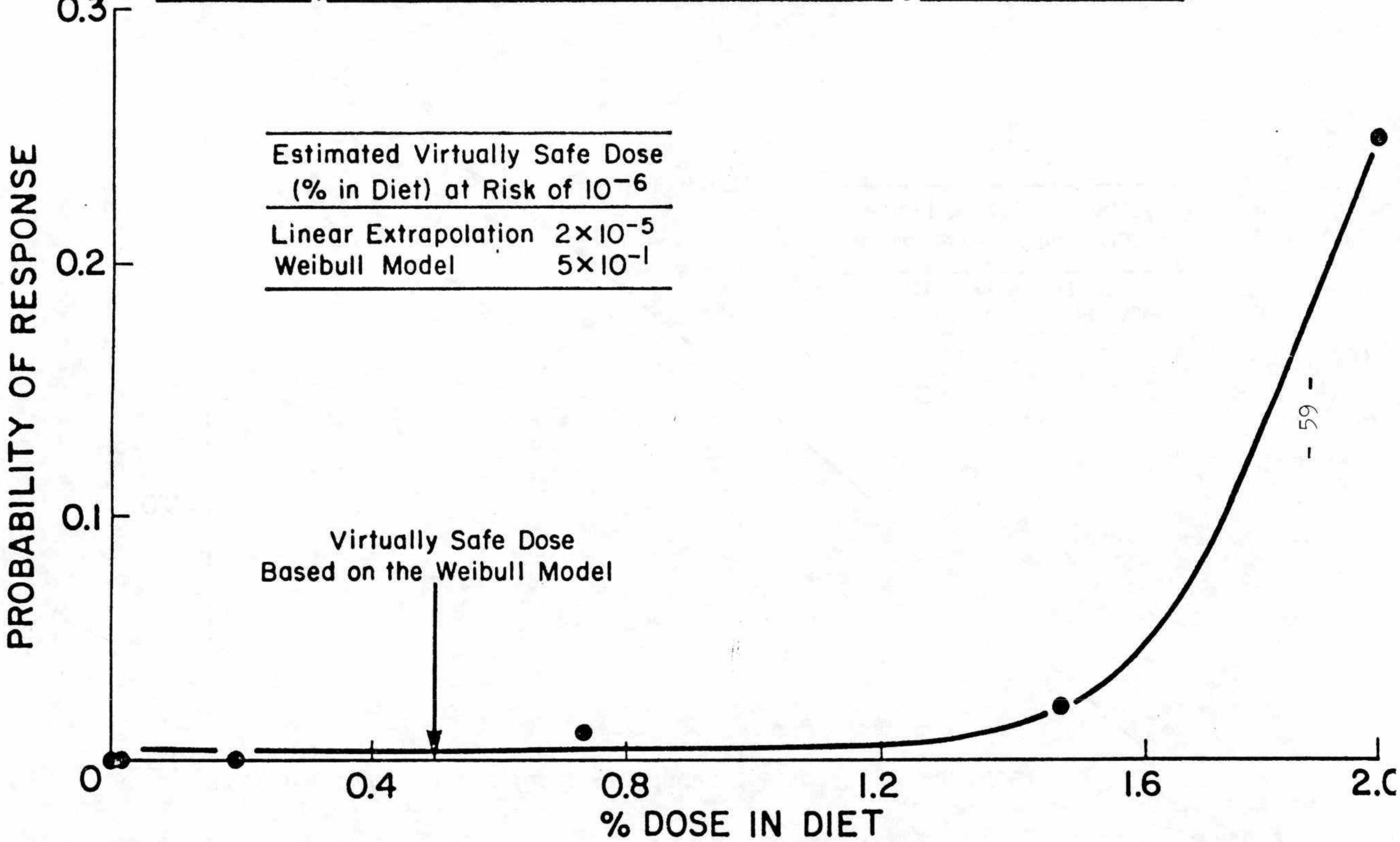
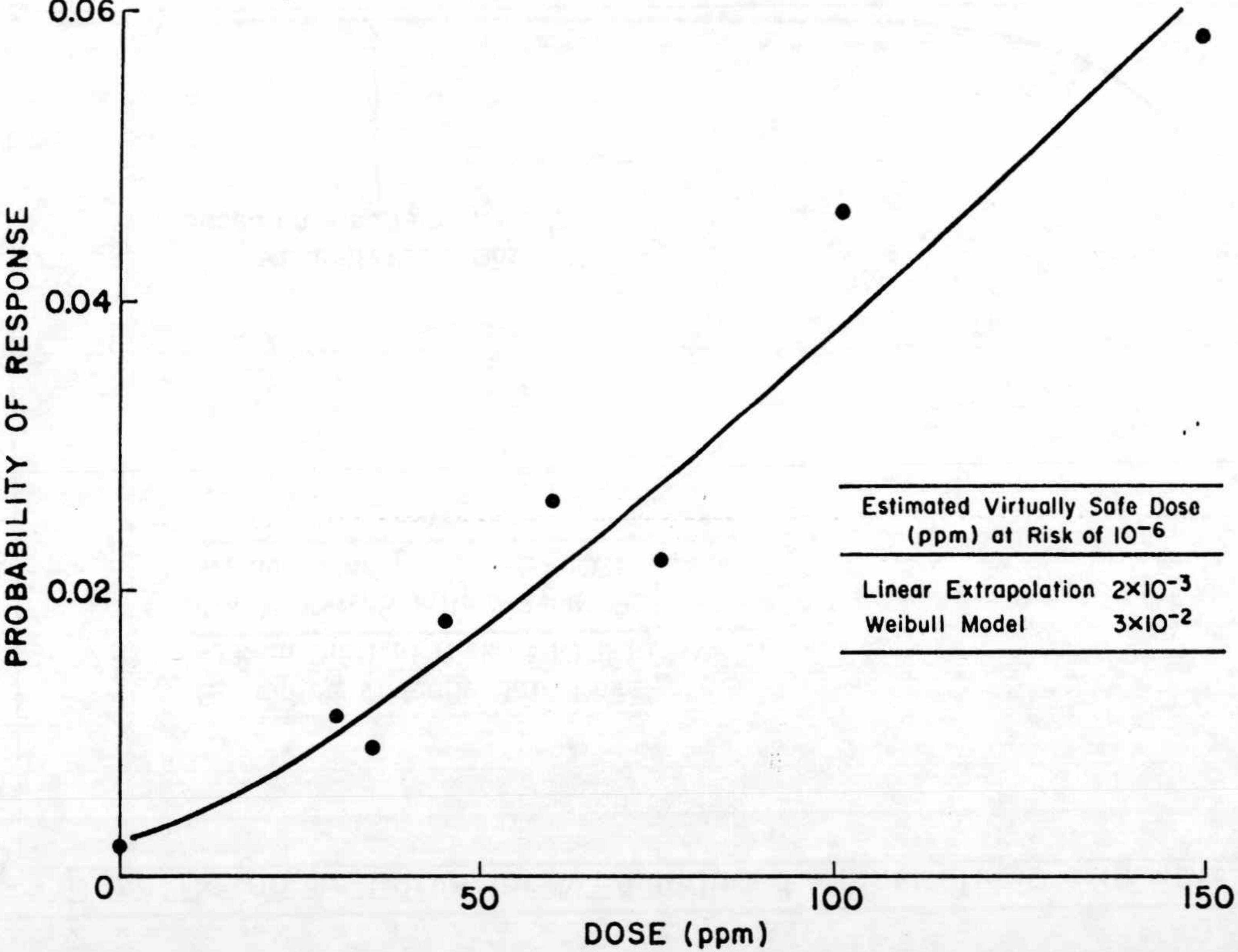


FIGURE 2

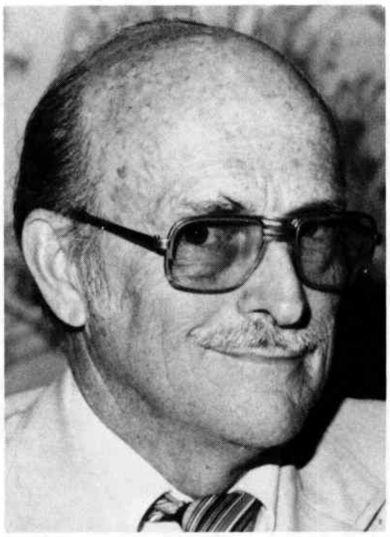
Dose Response Curve for 2-AAF Induced Liver Tumors in Mice



SESSION II - AIR QUALITY

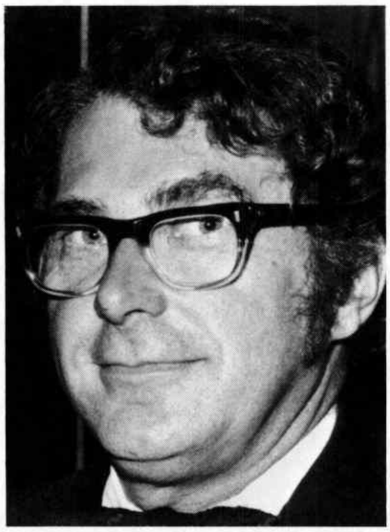
Chairman: Dr. R. W. Slater,
Regional Director General,
Ontario Region,
Environment Canada, Toronto

Anne Park, Head,
Environment Section,
U.S. Trans-Boundary Relations Review,
Department of External Affairs,
Ottawa, Ontario



Donald K. A. Gillies, Manager,
Environmental Protection, Thermal
Generation Division, Ontario Hydro, Toronto

Dr. C. Lucyk, Senior Economist,
Program Planning and Evaluation Branch
Ontario Ministry of the Environment



Dr. D. Pengelly,
Urban Air Environment Group,
McMaster University, Hamilton, Ontario

Status of Canada - U.S. Negotiations on Transboundary Air Pollution

by

Anne Park

United States
Transboundary
Relations Division
Department of
External Affairs

Transbounddary air pollution is a very important problem these days for the Government in its relations with the United States; it is also a problem on which we are working closely with the Government of Ontario and the other provinces. It was therefore with pleasure to accept the invitation to participate in this Conference.

I have been asked to speak to you on the subject of the status of Canada/U.S. negotiations on transboundary air pollution.

This is a very timely occasion for such a discussion - the Memorandum of Intent which Canada and the United States signed in August 1980 calls for these negotiations to begin this month. I am pleased to say that the negotiations will be going forward as planned.

In considering how best to approach this subject today, I was reminded of an editorial which I read in the press a couple of weeks ago, the gist of which was - Look at what's going on in the United States these days. Their policies and priorities have nothing to do with acid rain. Do those people in the Government really think they're going to negotiate a solution with the United States?

That is a point of view.

Certainly, there are a lot of reasons not to be optimistic that solutions will be achieved easily or quickly.

But that does not mean that we should be so discouraged that we quit before we start. I don't think that is the stuff of which Canadians are made. Nor, more importantly, do I think we can afford to. The threat which acid rain and other forms of transboundary air pollution pose to Canada's environment, its economy and indeed to its way of life means that we have no real choice but to press forward to the best of our ability, and find those solutions which we so desperately need. As my Minister, the Secretary of State for External Affairs, Dr. MacGuigan, said recently at an acid rain conference in Buffalo - "we will overcome because we must overcome".

That certainly is the attitude with which the Government is approaching the negotiation process.

I would like to examine this a little further by explaining some of the things which relate to these negotiations.

First, why we must overcome - why we need to have an agreement with the United States.

I don't think I need to convince most Canadians that acid rain is a serious problem. It has received wide recognition both by the Canadian public and by Governments, both federal and provincial. This can be seen in the wide attention given to the

issue by the media, in the actions taken by the Government of Ontario with INCO and Ontario Hydro to begin the process of reducing Canada's contribution to pollutant load, and in the unanimous decision by the Canadian Parliament last December to amend Canada's Clean Air Act to make it more effective in controlling air pollution crossing the international border.

I am making this point because, if I were giving this address in the United States, I would indeed probably be explaining at some length why Canadians are so concerned about acid rain and why U.S. action is needed to deal with it. The fact of the matter is that acid rain began to grow as a public issue in the United States only relatively recently compared with Canada. For this reason, a great deal of the Government's efforts have been going into trying to develop a common understanding with Americans on the need for cooperative action to reduce pollutant levels.

I probably also do not need to explain at great length why we need United States action - the fact that we receive in total about 50 per cent of our pollutant load from the United States, and in some areas probably more, makes it practically impossible for Canada to deal with the problem alone. This does not mean that we cannot or should not take some actions ourselves; it does, however, mean that because the problem is

generated by both countries, both countries need to be part of the solution.

This is an important point. If acid rain could be solved within Canada alone, life would undoubtedly be much simpler. The problem could be resolved entirely within our own political process, and not involve the much more complex problem of trying to resolve it with another country. Unfortunately, the essence of the problem - which is that air pollution by definition is not confined to political boundaries - means this cannot be the case.

What then makes us think this problem can be solved, beyond the determination of a great many Canadians to see this happen?

I would like to offer a few thoughts in this regard.

First, it is important to recognize that, at this point, there are simply a lot of things we don't know about what is going to happen on this issue. A number of statements have been made about environment in general and on acid rain in particular by members of the new Administration which are cause for some concern. However clear positions as such have yet to be adopted. Moreover, the U.S. Clean Air Act - the instrument which

determines U.S. ability to control air pollution - has just begun to be reviewed by the U.S. Congress. Because it is domestic legislation which must ultimately be used to implement an agreement, this review will be very important to the success of our efforts to achieve an effective solution.

What we do know is that Canada has received repeated assurances from the new Administration that it intends to cooperate with Canada on this problem. Such assurances were given to Prime Minister Trudeau by President Reagan when he visited Ottawa in March. They have also been repeated by other very senior members of the Administration. While it remains to be seen what these assurances mean in practical terms, they are very important, and we have told the U.S. government that we expect them to hold.

It may also be useful to explain the structure which has been put in place to develop means of dealing with this problem with the United States.

When the full dimension of the problem of long range transport of air pollutants, of which acid rain was a part, began to be appreciated, both countries put in place domestic research programs. Recognizing the importance of sharing information from these programs and ensuring that the methods used were

compatible, both Governments established in 1978 a Research Consultation Group. You may be familiar with the Group's first two annual reports.

It was clear, however, that cooperation in research alone was not enough; we also needed to move toward an agreed means of controlling the pollutants which were the source of the concern. In this reason, the two countries signed the Memorandum of Intent in August 1980.

The Memorandum does three basic things:

First, it commits both Governments to beginning the negotiations which are to start this month.

Second, it commits both Governments to take interim actions to deal with the problem pending conclusion of an agreement. The need for such measures is obvious; there is little point in trying to negotiate a solution to a problem if actions are simultaneously taken which make it worse. The interim actions included are the development and application of pollution control measures, advance notification and consultation on measures affecting the transboundary flow of pollutants, and cooperative research and monitoring.

The third thing the Memorandum does is to establish five Canada/U.S. Work Groups charged with preparing the technical groundwork for an agreement. These Groups are composed of technical, scientific, policy and legal personnel from both countries, and in Canada involve both federal and provincial governments. They are responsible to a Canada/U.S. Coordinating Committee, also composed of federal and provincial personnel. The Groups have completed one set of reports, and are working on more.

The Work Groups' role in the negotiations is very important because of the need to establish as a basis for negotiations as much common understanding and consensus as possible in the nature of the problem and the measures available to deal with it. The Groups are not themselves research bodies; both countries have long term domestic research programs for that purpose. Rather their job is to provide the best available information and the best judgements on the nature of the problem and the options available to control it. It is not an easy task, and we are very appreciative of their efforts.

The Work Group structure is patterned after a similar mechanism employed in developing the Great Lakes Water Quality Agreement. There too, Canada and the United States, established a series of technically oriented groups which analyzed the nature of the problem and proposed solutions.

The Great Lakes Agreement is relevant to the air pollution problem in other ways. While there are significant differences between the two situations, there are also some important parallels. The Great Lakes clean up effort is an example of how the two countries were able to give practical meaning to implementing their international responsibility to clean up a large scale pollution problem. Like air pollution this problem required the commitment of substantial financial resources and the involvement of a number of political jurisdictions. It is also worth noting that when Canada and the United States embarked on the Great Lakes clean up effort they didn't know everything there was to know about Great Lakes pollution. Indeed they had research programs underway, and still do. However, they did know enough to know they had a serious problem that required action be taken.

To set to rest any fears that we may be plunging into substantial new air pollution control requirements without a clear idea of what is needed, I might also note that the measures required in the two successive Great Lakes agreement were not impractical or unreasonable. There is no point in setting extreme goals which have no realistic hope of attainment, and will only frustrate serious efforts to deal with the problem. Rather, the measures required in the Great Lakes Agreement were calculated on the basis of what was environmentally sound,

economically viable, socially desirable and technically feasible. We will be doing well if we can get similar action underway to deal with air pollution.

However the key to the success of the Great Lakes effort was the commitment of both Governments to take serious steps to reduce pollution levels. It is this expression of political in both countries which will also be essential in taking effective measures to deal with acid rain.

As I mentioned earlier, there is some evidence that concern about the problem is beginning to grow in the United States, although it does not approach the level of concern in Canada. It appears likely this interest will grow as review of the United States Clean Air Act proceeds.

One of the more interesting developments recently the U.S. has been the growing concern between some states about the need for better means of controlling the flow of pollutants between jurisdictions that is, between the States themselves. The present legislation in both countries has been designed to deal primarily with local pollution effects, mainly because the implications of long range transport of air pollutants were not as well understood as they are today. In many respects, this concern of certain U.S. states is another manifestation of the

truism that air pollution knows no political boundaries - and is very similar to Canada's concern.

What makes the Canada/U.S. situation different from the inter state situation is that it is fundamentally a problem across an international rather than a domestic border. This means that the various costs and benefits involved in pollution control cannot be internalized within one political system. In other words, while it is the theoretically possible for one country alone to decide to pursue other societal goals at the expense of environmental protection, this is not acceptable in an international setting if it means that the costs are passed on to another country on the form of polution. This would conflict with the fundamental responsibility of states - recognized in international law - to prevent transboundary pollution damage.

In summary therefore, we are under no illusion that these negotiations will produce any quick and casy solutions. We also know however that there must be solutions and are determined to find them. We also know that both countries should have an interest in finding these solutions for domestic reasons and in order to deal with what has become one of the major problems in Canada/U.S. relations. I hope that we can count on the support of Canadians like yourselves as we approach this difficult task.

Determination of the Economic Significance of Acid Deposit Effects

by

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Note: Dr. Lucyk spoke from notes and personal experience and did not have a formal text of her paper for inclusion in these Proceedings.

Nanticoke Environmental Management Program (NEMP)

by

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- Chairman, Technical Committee, NEMP

1.0 INTRODUCTION

The industrial project developed around Nanticoke town in Haldimand County is one of the largest undertaken in Canada to date, with an investment exceeding that projected for the Alberta Oil Sands mining and refining operation up to the year 2000. A development of this magnitude has had a profound effect on an area which was previously largely agricultural. The three major industries, Stelco, Texaco, and Ontario Hydro, joined the Ministry of the Environment (Ontario) and Environment Canada in a cooperative air quality study called Nanticoke Environmental Management Program (NEMP).[1, 2]

The 4000 MW Ontario Hydro generating station is presently the largest fossil-fuel fired station in North America and is the major contributor to the atmospheric loading of sulphur dioxide at Nanticoke. The Texaco refinery at 100 000 barrels per day went into full production in 1978. The Stelco steel works went on-line in the spring of 1980 at a production level of 0.8 million tons of steel per year with a long-term future capacity of over 5 million tons. Emissions for 1980 from each of these large industries are given in the accompanying table.

1980 Emissions (In Mg)

	SO_2	NO	Particulate
Ontario Hydro (4000 MW)	144 000	36 300	2 000
Texaco (100 bbl/day)	6 800	1 600 (NO_2) 1 100 (NO)	260
Stelco (0.8 million tons/year)	170	1 260	145

Coal handling operations at Ontario Hydro and Stelco contribute to the dustfall loadings relatively close to these plants although coal dust control techniques are used to minimize this problem. Other emissions by the Nanticoke operations--mainly Stelco and Texaco--are hydrocarbons, various other gases (hydrogen sulphide, carbon monoxide), and fluorides and polynuclear aromatic hydrocarbons (in gaseous and particulate form). In addition to the primary

emissions, there exists the possibility of secondary pollutants such as ozone being generated from primary pollutants by atmospheric chemical reactions under certain meteorological conditions.

In 1975, the Regional Director of Central Region, Ministry of the Environment, Mr. C. Macfarlane conceived the need for a large scale management program to measure, assess, and control the changing state of the air environment. Following several meetings both within and without the MOE, the NEMP was developed and the plan was set in motion.

2.0 AIR QUALITY RESEARCH AND MONITORING IN NANTICOKE PRIOR TO NANTICOKE ENVIRONMENTAL MANAGEMENT PROGRAM (NEMP)

Since the early 1970s, a considerable amount of air quality-related work has been carried out in the Nanticoke area. A recent compilation [NEMP Technical Committee, (1980)][2] shows that, excluding the monthly air quality reports produced by Ontario Hydro and NEMP, more than 60 reports, presentations at scientific conferences, and publications in journals have appeared, many of them prior to the inception of NEMP. These dealt primarily with the meteorology and climatology of the Nanticoke area, phytotoxicological studies, and results of emission measurement and plume behaviour studies, and have contributed considerably to our present understanding.

Munn[3, 4] has given a good overview of meteorological studies in this area prior to 1977. Of special interest was the identification of onshore gradient or lake breeze flows as one of the most important potential problem conditions. During the growing season, these occur roughly 25 percent of the time [Weisman and Hirt],[5] and can lead to thermal internal boundary layers which may result in high ground-level concentrations through fumigation of chimney plumes [for a more complete discussion of this phenomenon, see Weisman and Hirt[5] and Portelli].[6, 7] Long-range transport of air pollutants has also been recognized for some time as a source of concern in the Lake Erie region. For example, even in the early 1960s, damage to tobacco plants in the area was attributed to oxidants imported mainly with southwesterly winds [Mukammal],[8] and subsequent studies have confirmed this early work not only for ozone, but also for airborne particulate matter [see, for example, Chung].[9] Furthermore, Munn,[3] in a report to the IJC Air Pollution Advisory Board, estimated that occasionally

sulphur dioxide emissions from Cleveland could cause air quality criteria for this pollutant to be exceeded on the north shore of Lake Erie, and his preliminary calculations have been supported by recent air quality measurements [Fleming].(10)

Starting in the early 1970s, air quality monitoring and air pollution plant damage studies intensified in the Nanticoke area, largely due to the efforts of Ontario Hydro and the MOE. By 1975, there were 16 Ontario Hydro operated sulphur dioxide monitors and a meteorological tower within a radius of about 20 km of the generating station, and MOE was operating several gaseous pollutant and hi-vol sampler monitoring stations, as well as dustfall jars and sulphation and fluoridation plates in the area. A hi-vol sampler network, operated by Dr. D. Pengelly of McMaster University and financially supported by MOE, Ontario Hydro, and Stelco, measured suspended particulate matter levels at several points in the southwest-northeast corridor from Long Point to Hamilton.(12) Vegetation plots were set up in a 40 km radius from Nanticoke, using sensitive plants to provide an indication of air pollution effects on vegetation.

The foregoing work showed that, following startup of the generating station sulphur dioxide concentrations exceeded the air quality criterion of 0.25 ppm hourly average relatively rarely, primarily during lake breeze and high wind conditions [Fleming].(11) Numerous ozone exceedances were also observed, attributed to long-range transport. These were thought to be responsible for the plant injury noted during this period (no sulphur dioxide or fluoride injury could be detected). Total suspended particulate matter concentrations were mainly in the 40 ug m^{-3} to 50 ug m^{-3} range, study results showed that the Nanticoke area can at times be influenced by emissions originating both at Hamilton and south of the border and from local farms.(12)

Several intensive studies were carried out during this period, mainly by Ontario Hydro. These were designed to examine plume rise and dispersion of the generating station emissions under various meteorological conditions, as well as chemical reactions in the plume (leading, for example, to the brown colour which can be at times observed over large distances downwind of the chimney). Also worth noting is the work of Weisman and Hirt(5) referred to above, and sponsored by Stelco, which highlighted the importance of possible fumigation problems in the area with onshore flows during the summer.

The scope of this paper does not permit a detailed discussion of the air quality research work carried out in the Nanticoke area and only some of the highlights have been mentioned. The reader is referred to the NEMP program review report noted above for more details.

3.0 THE NANTICOKE ENVIRONMENTAL MANAGEMENT PROGRAM (NEMP)

NEMP is a six to eight year program with a projected funding of about six million 1974 dollars, cooperatively undertaken by Environment Canada, MOE, Ontario Hydro, Stelco, and Texaco Canada. Each partner in NEMP retains his independence regarding funding, interpretation of data, and philosophy of maintaining air quality. Nevertheless, all benefit by mutual discussion and coordination.

3.1 Objectives, Organization, and Activities of Nanticoke Environmental Management Program

The objectives of NEMP are:

(1) To monitor air quality in the Nanticoke area.

(2) To assess the impact on air quality in the Nanticoke area of local industrial development and distant sources.

(3) To determine the effects of Nanticoke industrial operations on air quality at more distant receptor areas, including the US side of the border.

(4) To provide the basis for an effective and economical abatement strategy and air management program.

(5) To report its results regularly to the community.

Figure 1 illustrates the organization and activities of NEMP. The Management and Technical committees comprise representatives from all the participating agencies. The former gives overall direction to the program and approves the budget, while the latter plans the detailed scientific program and formulates recommendations. The NEMP coordinator, who is employed by the Ministry of the Environment to

coordinate studies among the participating agencies, is presently the chairman of the Technical committee, and a representative on the Management committee.

Current NEMP activities can be broken down into three broad areas - routine air quality monitoring, special studies related to air quality, and mathematical air quality modelling.

3.1.1 Routine Monitoring

There are three major routine monitoring networks providing air quality data for the NEMP data base:

(1) Ontario Hydro's sulphur dioxide network (already mentioned in the previous section) including a meteorological tower instrumented at three levels.

(2) The MOE West-Central Region's gaseous pollutant and airborne particulate matter monitoring network.

(3) The NEMP gaseous and particulate pollutant and precipitation monitoring network cosponsored by MOE, Stelco, and Texaco.

Two meteorological towers supply data on atmospheric temperature and wind speed and direction, while an acoustic sounder provides continuous mixing depth data. Gases monitored include sulphur dioxide, total reduced sulphur, nitrogen oxides, ozone, carbon monoxide, methane, and nonmethane hydrocarbons. Airborne particulate monitoring includes soiling index and particulate mass determinations in real time (using the beta-attenuation gauge), as well as 24-h average total suspended particulate (TSP) measurements using high volume samplers. Some TSP samples are also analyzed for particulate carbon and various polynuclear aromatic hydrocarbons. At a number of these hi-vol sites, parallel sampling is done with Whatman 41 (cellulose) rather than the usual glass fibre filter media. These particular samples are submitted for detailed chemical analyses including the following parameters:

sulphate, nitrate, chloride, fluoride, ammonium, phosphate, and various elements (cadmium, lead, chromium, manganese, copper, zinc, iron, vanadium, boron, calcium, magnesium, aluminum). Precipitation is monitored at seven locations, the samples being analyzed for acidity, major ions (including sulphates and nitrates), nutrients, and various trace metals. Continuous measurements of precipitation rate are also made at some locations.

Figure 2 shows the location of the air quality monitoring stations operating in the Nanticoke area, while Table A describes in detail the parameters measured at each site.

Ontario Hydro and MOE West-Central Region's instruments are maintained by their own technical staff. The instrumentation purchased and installed specifically for NEMP is operated by Moniteq Limited under contract to Stelco, Texaco, and MOE. Moniteq is also responsible for maintaining the NEMP database, and producing monthly reports containing the results of the NEMP air quality measurements. The data from all the above networks provide the input for a scientific analysis of air quality at Nanticoke.

Before leaving this section on routine monitoring, mention should be made of the data acquisition and processing system currently being installed by MOE at Nanticoke. At the moment, data loggers and associated telemetry equipment have been installed at four stations (Long Point Park, Jarvis Meteorological Tower, Cheapside, and Binbrook). Data is transmitted in real time to a Data-General Eclipse minicomputer located in the MOE offices at Toronto where it is displayed and stored for further processing. This telemetry network is presently being expanded to include eleven of Ontario Hydro's sulphur dioxide monitoring stations, and arrangements are being made to transmit data to Nanticoke and to Head Office at Toronto. Thus, MOE and Ontario Hydro scientists at Toronto will eventually have a real-time picture of air quality at Nanticoke.

3.1.2 Special Studies

A large investigation, jointly undertaken by Environment Canada, MOE, and Ontario Hydro, took place under the leadership of the Atmospheric Environment Service from May 29 to June 16, 1978. Its purpose was to study the diffusion conditions, during onshore flows, affecting the plume from the Nanticoke generating station. Meteorological measurements were made of the vertical structure of onshore flows and boundary layer development utilizing several different observational systems. Several surface mobile units as well as two aircrafts were used to obtain concurrent ground-level and airborne plume and regional air quality measurements [see Portelli].[6, 7] This study was followed by a smaller one with the same objectives, by MOE, during May 29 to June 14, 1979. Reports describing the detailed results of these investigations are currently in preparation. When the analysis of these results has been completed, we should have a good understanding of how the industrial emissions behave under one of the most important potential problem meteorological conditions. Some other special studies in the Nanticoke area during the past few years, which might be mentioned here, are:

(1) An investigation of generating station plume behaviour under wintertime conditions.

(2) Measurements of airborne particulate matter chemical composition as a function of particulate size.

(3) A study to determine hydrocarbon levels in the vicinity of Texaco.

(4) Generating station plume chemistry and precipitation washout in the generating station plume.

3.1.3 Mathematical Modelling, Development of Abatement Strategy, and Air Management Programs

Mathematical modelling of emissions and resulting air quality is an important part of the studies in NEMP. Models are being

developed cooperatively by the Atmospheric Environment Service, Ontario Hydro, and MOE. These models can be broken down into two broad categories - short-range and long-range. The long-range models will allow us to quantify the impact of Nanticoke operations on southern Ontario and surrounding communities in the US, as well as the extent to which other, distant sources contribute to air quality deterioration in the Nanticoke area. The short-range models predict air quality as a function of industrial emissions and meteorological conditions at distances out to about 20 km from the major industries, and may eventually be used in air management programs for the Nanticoke area if and when required.

3.2 Nanticoke Environmental Management Program Results to Date and Future Plans

The NEMP extension to the Nanticoke area air quality monitoring networks began during the summer of 1978. A data base has been set up to accept air quality data for the Nanticoke area, and has been used to produce monthly data reports since October of 1978. This data base contains:

(1) NEMP gaseous pollutant and airborne particulate matter concentration measurements.

(2) Meteorological data for the area.

(3) Results of the detailed chemical analysis of precipitation and airborne particulate matter samples.

(4) Results of the data generated by Ontario Hydro and West-Central Region networks in the Nanticoke area (Figure 3).

A preliminary survey of the NEMP data has confirmed the earlier air quality measurements mentioned in Section 2.0; namely, that gaseous pollutant and suspended particulate matter concentrations in the area are generally low, and air quality exceedances have been rare to date. A more detailed analysis is now underway, and reports are in preparation interpreting air quality in the Nanticoke area as a function of local industrial operations and meteorological conditions, as well as long-range transport.

Special studies and ongoing measurements in the area have already elucidated several questions related to local meteorological conditions and pollutant dispersion. More special studies are being planned. The development of short- and long-range mathematical models is also proceeding, and various air quality management options are being considered. For example, Ontario Hydro was given a Control Order to reduce gaseous emissions from all fossil stations to 300 000 tons by 1990, a reduction of 42 percent from levels of 1980.

A literature review of all relevant air quality work in the Nanticoke area has been completed,(1) outstanding problem areas have been identified, and recommendations for future action made. These will be implemented in the remaining years of the program.

4.0 COMMUNICATION

Communication with the public is done by organizations on an individual basis. As well, public seminars are organized jointly by public relations staff of the member agencies under direction of the Technical and Management Committees.

Copies of all reports prepared from the data collection network are filed with the NEMP library of the Air Resources Branch. Reports or presentations based on work funded by more than one of the member agencies are subject to review by the NEMP Committees before release. Otherwise, individual participants are free to release their own work on their own terms.

5.0 SUMMARY

A cooperative industry-governmental program, NEMP, has been launched to monitor air quality and study the impact of industrial development in the Nanticoke area. This program was built on previous studies and operates one of the most intensive air monitoring networks in Canada. As well, it conducts special studies to better understand the contribution of local and distant sources to Nanticoke air quality. Cooperation among all participants has been good, and duplication has been eliminated by pooling resources and sharing results.

References

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(5) Weismann, B. and Hirt, M.S., "Dispersion Governed by the Thermal Internal Boundary Layer," 68th Annual Meeting of Air Pollution Control Association, Boston, June 1975.

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(9) Chung, Y.S., "Ground-Level Ozone, Sulfates and Total Suspended Particulates in Canada," International Clean Air Conference, Brisbane, May 1978.

(10) Fleming, R.A., "Long-Range Transport of Sulphur Dioxide: A New Perspective," Ontario Hydro Report CTS-07148-1, June 1979.

(11) Fleming, R.A., "Nanticoke TGS Sulfur Dioxide Control: An Assessment of Need," Ontario Hydro Report CTS-07171-1, January 1979.

(12) Gschwandtner, G., Ritter, K., and Pengelly, L.D., "Particulate Pollution in the Hamilton-Nanticoke Region," Air Pollution Laboratory, Department of Medicine, McMaster University, January 1977.

Figure 1

Organization and Activities of NEMP

Management Committee

Technical Committee

NEMP Coordinator

Routine Monitoring

- Gaseous pollutants (SO_2, TRS, NO_x O_3, CO, hydrocarbons)
- Particulate pollutants (hi-vol sampling for TSP, sulphates, nitrates, trace metals; B-gauge for high time resolution measurements)
- Precipitation
- Meteorological parameters

Special Studies

- Intensive, short-term studies of meteorological conditions which lead to air quality problems
- Airborne studies of plume chemistry and dispersion, long-range transport
- Sizing and chemical analysis of airborne particulate matter
- Source strength determination

Mathematical Modelling

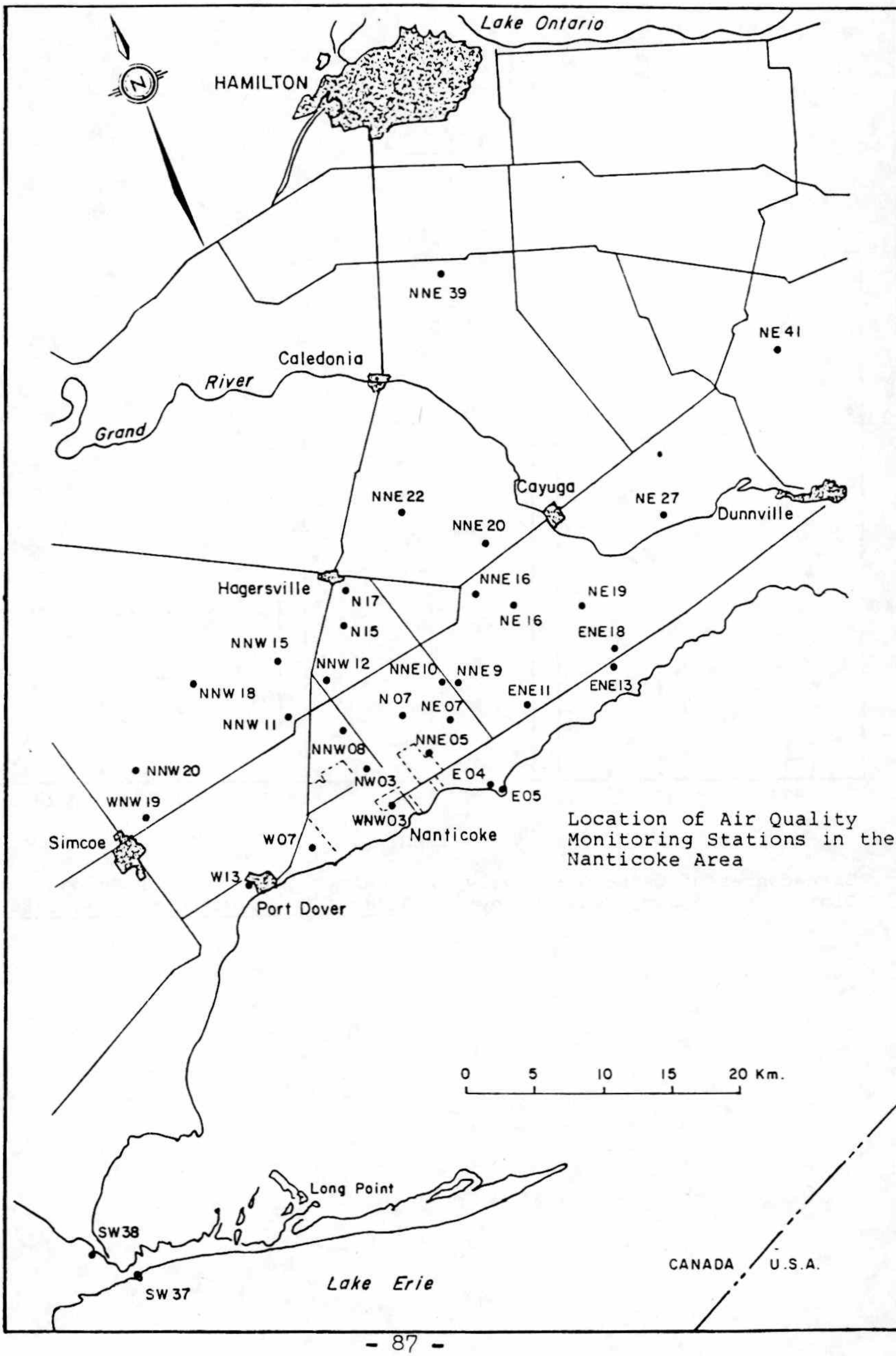
- Short-range model
- Long-range model

Notes:

1. The two committees are staffed from the five partners in NEMP, ie, Environment Canada, Ministry of the Environment, Ontario Hydro, Stelco, and Texaco Canada Incorporated.

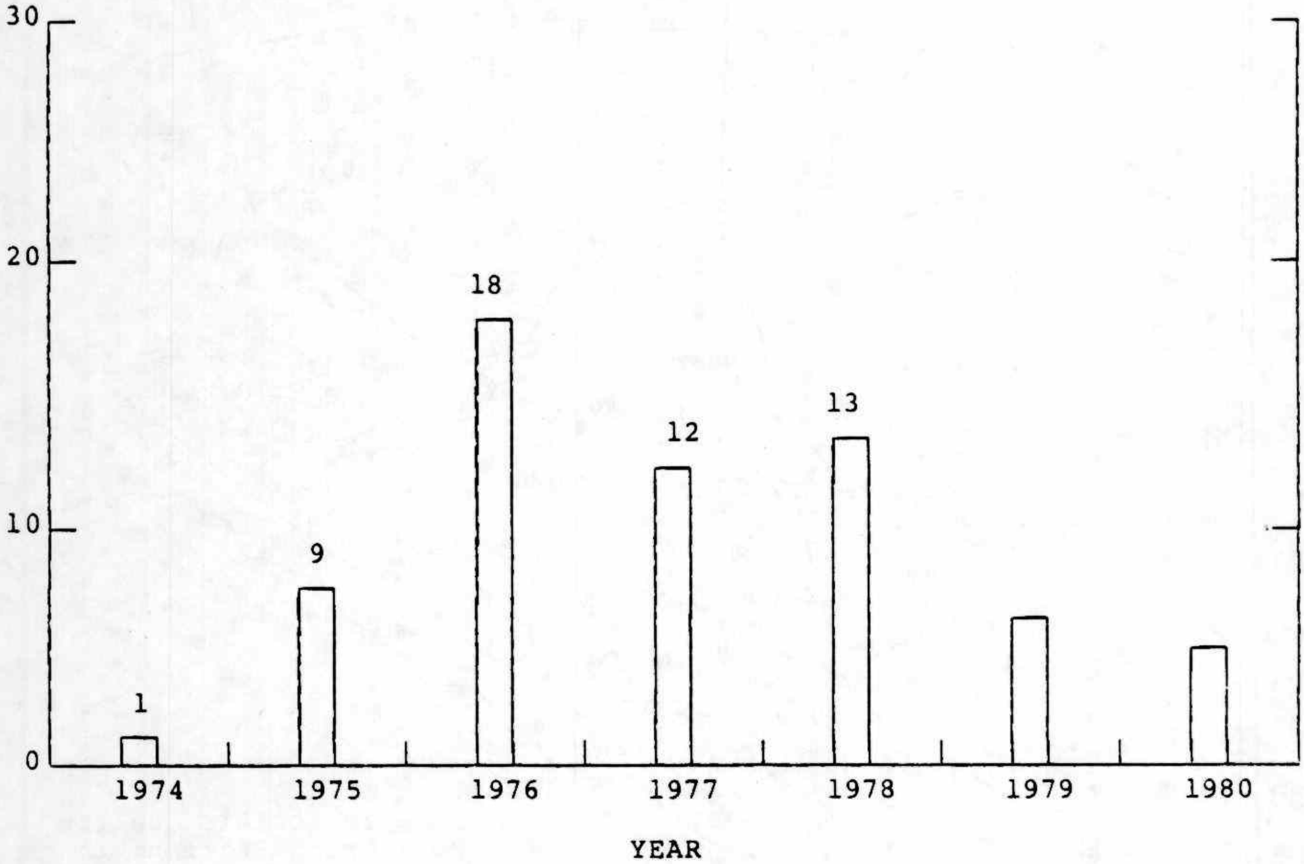
2. The NEMP Coordinator is employed by the Ministry of the Environment.

Figure 2



Location of Air Quality Monitoring Stations in the Nanticoke Area

Figure 3



Exceedances of Ontario's Hourly Air Quality Criterion for Sulphur Dioxide (0.25 ppm) Measured by the Ontario Hydro Network, 1974-1980

Table A

Summary of Operating Nanticoke
Environmental Management Program
Instruments (Listed by Site)

Geographical Identification	Site Name	Instrument Compliment and Notes	Maintained By
SW37	Long Point Park	SO_2,O_3, NO_x, CO TSP Hi-Vol Comp Hi-Vol TSP Beta Gauge CoH	NEMP Contractor
	Meteorological Tower	30 ft wind spd/dir 100 ft wind spd/dir	
SW40	Big Creek	Precip Gauge Precip Collector	NEMP Contractor
W07	Dogs Nest East	TSP Hi-Vol Comp Hi-Vol Precip Collector Precip Gauge	NEMP Contractor
W13	Port Dover	SO_2 -------------------- TSP Hi-Vol	Ontario Hydro ---------- MOE/WCR
WNW03	Nanticoke Village	SO_2 -------------------- TRS	Ontario Hydro ---------- NEMP Contractor
WNW19	Simcoe Horticultural Station	SO_2, O_3, NO_x, HC	MOE/WCR
WNW20	Bloomsburg	SO_2	Ontario Hydro
NW03	Nanticoke North	TSP Hi-Vol Comp Hi-Vol	NEMP Contractor
NNW06		TSP Hi-Vol	NEMP Contractor
NNW08	Nanticoke Road	SO_2 -------------------- TRS,HC	Ontario Hydro ---------- NEMP Contractor

Geographical Identification	Site Name	Instrument Compliment and Notes	Maintained By
NNW11	Jarvis	SO_2	Ontario Hydro
		TSP Hi-Vol	MOE/WCR
NNW12	Jarvis Met Tower	10 m wind speed/dir 10 m temperature 32 m wind speed/dir 85 m wind speed/dir 85 m temperature	Ontario Hydro
NNW15	Livingston	SO_2	Ontario Hydro
NNW18	Villa Nova	TSP Hi-Vol Precip Collector	NEMP Contractor
N07	Sandusk	SO_2	Ontario Hydro
		NO_x	NEMP Contractor
		TSP Hi-Vol	MOE/WCR
N15	Garnet	SO_2	Ontario Hydro
N17	Hagersville South	TSP Hi-Vol Comp Hi-Vol	NEMP Contractor
NNE05	Walpole South School	SO_2	Ontario Hydro
		TRS, HC TSP Hi-Vol Comp Hi-Vol	NEMP Contractor
NNE09	Dry Creek	SO_2	Ontario Hydro

Geographical Identification	Site Name	Instrument Compliment and Notes	Maintained By
NNE10	Cheapside	SO_2, NO_x, COH TSP Hi-Vol -------------------- TRS, HC TSP Beta Gauge	MOE/WCR ---------- NEMP Contractor
NNE16	Balmoral	SO_2	Ontario Hydro
NNE20	Decewsville	SO_2	Ontario Hydro
NNE22	Dufferin North	TSP Hi-Vol Precip Collector	NEMP Contractor
NNE39	Binbrook West	SO_2, O_3, NO_x,CO TSP Hi-Vol CoH Precip Collector Precip Gauge	NEMP Contractor
NE07	Dry Creek West	Acoustic Sounder	NEMP Contractor
NE16	Fisherville North	TSP Hi-Vol Comp Hi-Vol	NEMP Contractor
NE19	Kohler Road	SO_2	Ontario Hydro
NE27	Canfield South	TSP Hi-Vol Precip Collector Precip Gauge	NEMP Contractor
NE41	Canboro East	TSP Hi-Vol Precip Collector	NEMP Contractor
ENE11	Selkirk	SO_2 -------------------- TSP Hi-Vol	Ontario Hydro ---------- MOE/WCR

Geographical Identification	Site Name	Instrument Compliment and Notes	Maintained By
ENE17	Rainham Centre South	TSP Hi-Vol Comp Hi-Vol	NEMP Contractor
ENE18	Rainham Centre	SO_2	Ontario Hydro
E04	Peacock Pt Park	TSP Hi-Vol Comp Hi-Vol	NEMP Contractor
E05	Peacock Pt	SO_2	Ontario Hydro

Abbreviations: COH - Coefficient of Haze; HC - Hydrocarbons; MOE/WCR - Ministry of the Environment, West-Central Region. Note also that the geographical identification indicates direction and distance (kilometres) from the Ontario Hydro generating station.

SO_2 - Sulphur Dioxide
O_3 - Ozone
NO_x - Oxides of Nitrogen
CO - Carbon Monoxide
TRS - Total Reduced Sulphur
TSP - Total Suspended Particulate

THE HAMILTON STUDY: EFFECT OF THE BREATHING ENVIRONMENT ON THE RESPIRATORY HEALTH OF CHILDREN

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Hamilton, Ontario is an industrial city located at the southwestern end of Lake Ontario and is the primary location of the steel industry in Canada. In the last two decades it has improved its ambient air quality by an order of magnitude. There remains a concern on the part of its citizens that the current levels of air pollution have a negative health effect, and community pressure is still strong to reduce air pollution to even lower levels. Existing evidence from studies around the world does not help to resolve the question of the health effects (if any) of continued exposure to the low levels of pollutants found in many industrial cities where efforts have succeeded in reducing the levels close to desired "standards" or "objectives". In the summer of 1977, a two-month pilot study in two schools in Hamilton demonstrated that: (a)Major differences in pollution levels existed, and (b)A study involving schoolchildren to assess the health effects of the breathing environment was feasible.

STUDY DESIGN.

Sample.

From the results of the pilot study, as well as previous information we had with respect to air pollution in Hamilton, it appeared that we could logically divide the city into four roughly equal quadrants. The Niagara escarpment, running roughly east-west, divides the city into lower and upper halves, north and south; and a major street divides it into east and west. Thus we have east and west lower, and east and west upper quadrants.

Hamilton has a population of over 300 000, in which there are children in the age range 7 to 10 yr approximately 11 000 in number. From the pilot study it was determined that we would need approximately 3 200 children to study, if we planned to divide up the city into 4 equal quadrants having 800 children in each. All public elementary schools in Hamilton constituted the sampling frame, and some 30 schools were randomly selected from the four quadrants to ensure an even geographic distribution of the children. Within each school, all children in levels 2, 3, and 4 who were aged 7 to 10 years were selected for study. Once a school, and hence a group of classes at levels two, three, and four were selected, then individual children could be identified. School lists were obtained, and letters sent to the parents requesting their co-operation, and informing them that they would be contacted by one of our trained survey team. A field worker would make the next contact by telephone to set up an appointment, and then the questionnaire would be administered to a parent or guardian at the appointed time. Interviewers were randomly assigned new areas each day, and the sequence of schools to be interviewed and tested was also taken at random. There were two teams of pulmonary function testers who were alternately assigned to schools in the upper and lower city.

Response Rates.

For each quadrant of the city there were more than the required number of interviews completed in Year 1, and again in Year 2, the response rate being in excess of 95% of those eligible in both years. Over 85% of the children tested in Year 1 were retested in Year 2, and this rate is holding steady for the first half of Year 3 already completed. For any survey these are unusually high figures, and we are most grateful to our skilled teams of interviewers and testers for their excellent work.

Interviews.

The interviewers inquire about the child's respiratory health by asking questions about cough, wheezing, days off school because of respiratory illness, and frequency and type of colds. In addition, aspects of the home environment such as housing, smoking in the home, cooking fuel, residential history and socio economic factors were explored via the questionnaire. At the end of the interview (which took 15 minutes), consent for the child to participate in the pulmonary function test was requested.

Pulmonary Function Testing.

Pulmonary function was measured on the children in the schools by two pulmonary function teams, each using a Hewlett-Packard 47804A pulmonary calculator system. Each system was mounted in a heavy steel console desk,and equipped with isolating transformers for an added measure of electrical safety. Each system has by now been moved over 100 times, and for the most part has performed well under difficult conditions.The teams produce reports consisting of age, weight, height, sex, race, FVC, FEV1, MMEF, FRC, CV, CC and other indices of pulmonary function. In excess of 20 indices are measured or computed. Local environmental conditions (temperature , humidity, pressure and time) are also recorded.

QUALITY CONTROL.

Interviews.

A random sample of 5% of all the respondents were telephoned and questions taken at random were re-asked. In all cases the interview was found to have been done, but in some 11% of the cases there was a difference between the response to the question the first and the second time. Most of these errors were resolved or considered not to be a problem. Some were likely real changes in the health status of the child, since a different time period was being asked about. No significant differences were found to be attributable to interviewers.

Pulmonary Function.

Eight children from each school (selected randomly) were re-tested. The reproducibility of most of the tests was found to be acceptable, and in those tests where a slight change was observed, it could be attributed to a "practice effect". The results of one team could also be compared with the other, and over each year testing period no systematic differences were found between teams.

All data were coded, keypunched and verified before being stored on computer file. Five % of all data taken at random were recoded

by an alternate coder, and for pulmonary function tests the error rate was between 1 and 2%, while for the questionnaire the error rate was less than 0.5%. Range checks were run on all data at data storage time, yielding rates up to 3.6%, most of which were easily resolved. Quality control procedures such as these have not previously been described for epidemiological studies of air pollution.

EXPOSURE ESTIMATION.

Particulate monitoring.

TSP and PSD samplers were evenly distributed throughout Hamilton in the four quadrants in an attempt to establish the nature of the particulate size and loading gradients throughout the populated areas of the city. The TSP monitors are standard Hi-Vol samplers, uşing glass fibre filters, and operating at 40 cubic feet per minute (cfm) for 24 hr.on a 6-day cycle. Particulate Size Distribution (PSD) was obtained from Andersen cascade impactors operated at a flow of 20 cfm, on the same six day cycle. Filters are carefully weighed before and after exposure in a humidity and temperature controlled environment on a standardized balance, and the weights are used to estimate TSP and PSD with standard procedures in micrograms per cubic meter.

Sulphur Dioxide.

SO2 is measured at 16 sites distributed evenly throughout the four quadrants. For six weeks of each season, instruments were placed in eight of the sites, followed by a further six weeks in the second group of eight sites. Beckman SO2 analyzers are rotated through the sites and are checked every three days. A tunable diode laser system has been constructed and calibrated to measure SO2 in parts per billion (ppb) concentrations. This portable laser system and a similar laboratory device are used to keep a constant calibration check on the Beckman instruments. Hourly readings of SO2 are available from the eight sites, but mean values over days, months or seasons have been used so far in preliminary analyses.

Exposure Estimation.

Standard regression techniques have been used to fit bivariate response surfaces to the air quality measurements using the sampling station location in an east-west and north-south grid system as input. The air quality measurments fitted so far are monthly, seasonal, and yearly means at the sampling stations for TSP and SO2. Geometric means were used to combine the TSP measurements, while arithmetric means were used for SO2 measurements. The coefficients of determination produced by this process indicated that more than 50% of the variation in TSP responses in a month can be explained by a quadratic model in location. Similar models have been fitted to the SO2 data. Once a model has been developed, it is possible to estimate the exposure for that month (or other time period) at the school and home locations within the city. By using these estimates of air qulity at specific locations for particular time periods, exposures could be individualized to school, home, and possibly even a child measured at a particular time who spent P proportion of the time at school and (1-P) proportion at home.

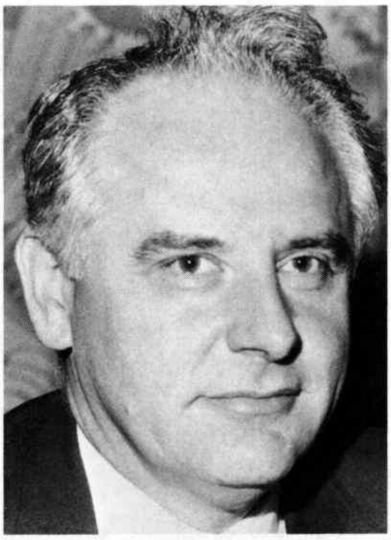
INDOOR SAMPLING.
A modification of the Yale personal sampler has been developed for use as an indoor multipollutant sampler. Measurements of SO_2, NO_2 and suspended particulate are made, averaging over a 24 hr. period. The sampler is quiet, unobtrusive and line-operated, and can be serviced in a few minutes. Two networks of indoor samplers; 16 schools and 24 homes have been set up, together with complementary similar outdoor samplers. The networks are designed to provide broad geographical coverage, as well as to examine the indoor-outdoor ratio of different types of structures. This information plus a detailed questionnaire related to building insulation, heating and cooling technology, windows etc. should provide us some more insight into the breathing environment of the children in the study.

RESULTS.
Although the study is not yet complete, some preliminary results are already available. It is clear that significant gradients in air quality exist across the city of Hamilton. If outdoor air quality were the only variable in the breathing environment of the children, its interrelationship with health effects would be relatively easy to define. However there are several "confounding variables" which we already know have some impact on respiratory health, such as the use of gas for domestic cooking, smoking in the home, number of children in the same room, and family income. In all cases, the distribution of these confounding variables is such as to produce potential adverse health effects in the same direction as that of increasing pollution levels. Thus in the final analysis of this study we must take great care in allowing for the effects of these confounding variables, in order not to inappropriately attribute a burden of negative health effect to air pollution.

The project is currently half way through its last data-gathering year, and there will be a further six to nine months of data analysis at the end. Our ultimate aim is to produce a list of a dozen or so factors in the breathing environment that can be shown to have a negative health effect, and a percentage of the burden attributable to each factor.

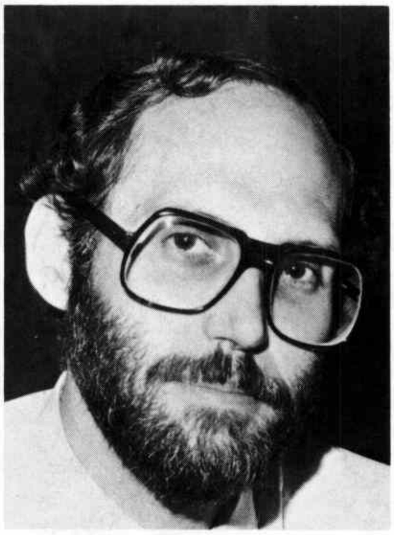
FUNDING.
This project is being supported by: Canada, Health and Welfare; Ontario Ministry of the Environment, and Ministry of Health.

SESSION III – HAZARDOUS CONTAMINANTS

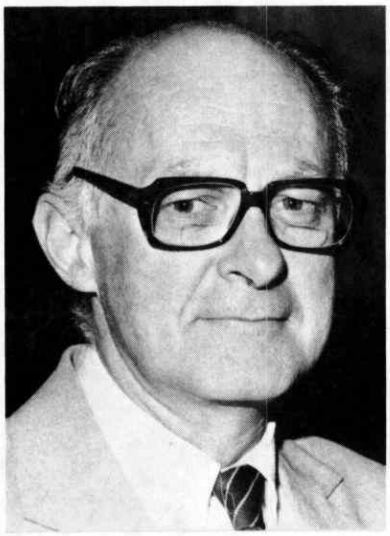


Chairman: J. C. McMahon,
Principal Water & Solid Wastes Engineer,
New York State Department of Environmental Conservation, Buffalo, N.Y.

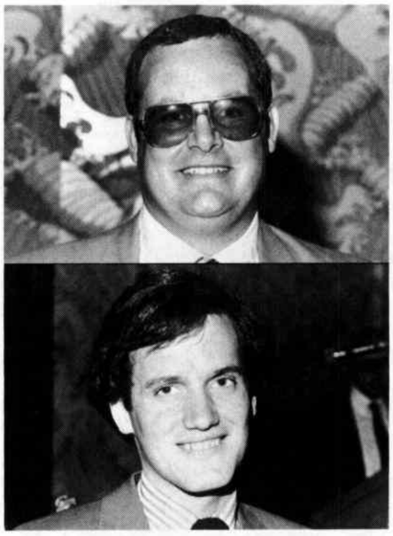
C. E. Duncan, Hazardous Contaminants Co-ordinator, Resources Management, Ontario Ministry of the Environment



Dr. R. D. Smillie, Project Scientist, Laboratory Services Branch, Pesticides Section, Environment Ontario



Robert L. Collin, Chief Toxic Substances Control Unit, New York State Department of Environmental Conservation, Albany, N.Y.



Top – A. F. Thomas, General Manager, Thomas Waste Removal Ltd., Toronto; Bottom – R. B. Warren, General Counsel to the Ontario Liquid Waste Carriers Association

The Role of the Hazardous Contaminants Office

by

C.E. Duncan
Hazardous Contaminants
Co-Ordinator
Ontario Ministry of Environment

INTRODUCTION

SLIDE 1 This morning the purpose of my presentation today is to familiarize you with the Ontario Ministry of the Environment's Hazardous Contaminants program. **Could I please have the lights down.** Before I go any further however, I would like to define what a hazardous contaminant or substance is:

SLIDE 2 a hazardous substance is a chemical substance of man made or natural origin which, when present in the environment, may produce severe adverse effects, acute or chronic, on humans or biota, usually through low level exposure.

During this presentation I plan to cover six areas:

SLIDE 3 current Ontario Legislation regarding hazardous contaminants, Ministry of the Environment - a historical perspective, the present Hazardous Contaminants Program in terms of organization and structure, the strategy for the management and control of hazardous substances, future direction and finally, what the Hazardous Contaminants Office can do for you.

HAZARDOUS CONTAMINANTS PROGRAM

ONTARIO MINISTRY OF THE ENVIRONMENT

HAZARDOUS SUBSTANCE - A CHEMICAL

SUBSTANCE OF MAN MADE OR NATURAL ORIGIN

WHICH WHEN PRESENT IN THE ENVIRONMENT

MAY PRODUCE SEVERE ADVERSE EFFECTS

(ACUTE OR CHRONIC) ON HUMANS OR BIOTA

ONTARIO LEGISLATION - HAZARDOUS CONTAMINANTS

- MOE INVOLVEMENT - HISTORICAL BACKGROUND

- MOE HAZARDOUS CONTAMINANTS PROGRAM - ORGANIZATION AND STRUCTURE

- STRATEGY FOR THE MANAGEMENT AND CONTROL OF HAZARDOUS SUBSTANCES

- FUTURE DIRECTION

- WHAT THE HAZARDOUS CONTAMINANTS OFFICE CAN DO FOR YOU

HAZARDOUS SUBSTANCE LEGISLATION IN THE PROVINCE OF ONTARIO

SLIDE 4

The Acts and Regulations in force in the Province of Ontario for the preservation of the environment are not specific to hazardous substances. Several Acts however are specific to the point that hazardous substances are encompassed.

SLIDE 5

The next slide presents 15 Acts which have some sections that are pertinent to the natural environment. I will be dealing with the four that are highlighted and are under the jurisdiction of the Ministry of the Environment.

These are:

SLIDE 6

The Environmental Protection Act
The Ontario Water Resources Act
The Pesticides Act
and the Environmental Assessment Act.

I would like to summarize the authority of these Acts in terms of hazardous contaminants.

The Environmental Protection Act

The Act was first proclaimed in 1971 and has had several revisions and is presently undergoing further change. The Act covers all phases of the environment, air, water and waste in relation to any contaminant.

HAZARDOUS SUBSTANCE LEGISLATION ONTARIO

PROVINCIAL ACTS

Environmental Protection Act

Ontario Water Resources Act

Pesticides Act

Environmental Assessment Act

Occupational Health and Safety Act

Public Health Act

Ontario Navigatable Water Probation Act

Lakes & River Improvement Act

Energy Act

Consumer Protection Act

Cancer Rendering Act

Health Disciplines Act

Livestock Medical Act

Gasoline Handling Act

Mining Act

ENVIRONMENTAL PROTECTION ACT

ONTARIO WATER RESOURCES ACT

PESTICIDES ACT

ENVIRONMENTAL ASSESSMENT ACT

EPA

The Act prohibits the deposit or discharge of any contaminant into the natural environment which may impair the quality of the natural environment for any use that can be made of it, cause injury or damage to property or to plant or animal life, cause harm or material discomfort, affect the health or impair the safety of any person and, finally, to render any property or plant or animal unfit for use by man.

With respect to hazardous contaminants, the most important sections of the Act are Sections 83 and 8. Section 83 permits a designated Provincial Officer to enter a site or plant and make surveys and examinations of books and records. This information is confidential except in respect of the deposit, addition, emission or discharge of a contaminant. Based on this report, the Director may issue a Control Order outlining the required action to be taken and the dates by which it must be done.

Section 8 of the Act requires prior approval from the Ministry for any new processes that may emit or discharge a contaminant into the natural environment other than water. Thus any new production of toxic substances would be examined to ensure the permissible emission rate is met.

Ontario Water Resources Act

This Act gives the Ministry of the Environment extensive powers to regulate water supply, sewage disposal and the control of water pollution. It authorizes the Ministry to supervise and examine all surface waters and ground waters in Ontario, to determine the extent, nature and causes of contamination in these waters.

This Act does not contain environmental standards for specific substances; it does however provide the overall definition of what may constitute impairment or pollution of the aquatic environment. The document "Water Management, Goals, Policies, Objectives and Implementation", November 1978, provides goals, policies and where possible, specific objectives as to what constitutes acceptable water quality. In addition to outlining objectives for a number of toxic substances, the policy is to require case-by-case examination of any proposal to release any hazardous contaminants for which Provincial water quality objectives have not been established.

The Pesticides Act

The Ontario Pesticides Act is the tool for control and enforcement within the Province of the laws and regulations promulgated by the Canadian federal government. The purpose of the Act is to ensure the safe and sound management of pesticides in Ontario.

This Act controls the sale and use of all pesticides sold in Ontario. Pesticides are classified into six schedules on the basis of their toxicity, environmental or health hazard, persistence of active ingredient or its metabolites, concentration, and usage. Distribution, availability, storage, and use are closely regulated.

The Act was promulgated in 1967 and revised in 1973 with Regulation 618/74, passed in 1974.

The Environmental Assessment Act, 1975

This Act provides for the assessment of any proposed major undertaking, governmental, municipal, and certain proposals from the private sector. The assessment is made at the very earliest stage to permit alteration or even cancellation of the undertaking should it be environmentally unacceptable. It also provides for full public participation in the decision making process.

SLIDE 7

In addition, there are a number of Federal Acts which have jurisdiction in the area of hazardous contaminants.

By name the major Acts are: The Fisheries Act, the Clean Air Act and the Environmental Contaminants Act - of which the latter is most important with respect to hazardous substances.

The Environmental Contaminants Act administered under the Environmental Protection Service provides the power to investigate substances or classes of substances to determine their hazard and to develop regulations for their control.

Sections 3(1) and 4(1) of this Act permit the government to gather information and ascertain "whether any substances are entering or are likely to enter the environment in quantities that may constitute a danger to human health or the environment".

This may be done by notification through the Canada Gazette or a notice can be sent directly to any person engaged in any commercial, manufacturing or processing activity requiring reporting of the use of a specified substance.

After reviewing the data, a decision is made either that:

(a) the use of the substance poses no threat to human health or the environment

(b) more information is required to complete the assessment

(c) the substance should be controlled

The Ontario Ministry of the Environment is actively persuing an information sharing agreement under this Act.

FEDERAL ACTS

FISHERIES ACT

CLEAN AIR ACT

ENVIRONMENTAL CONTAMINANTS ACT

HISTORICAL BACKGROUND

HAZARDOUS CONTAMINANTS TECHNICAL COMMITTEE

- ORGANICS GROUP
- INORGANICS GROUP
- RADIONUCLIDES GROUP
- INVENTORY GROUP

MOE - HISTORICAL BACKGROUND

SLIDE 8

In 1974 a Hazardous Contaminants Technical Committee was established. This committee included representatives from regional and branch offices of the Ministry of the Environment, Ministry of Labour, Ministry of Health, Ministry of Industry & Tourism, and the Federal Environmental Protection Service. Activities were carried out through four working groups. A working group for organic substances, inorganic substances, radionuclides, and an inventory group to develop a quantitative data base on chemicals in Ontario.

The major achievements were the establishment of a hazardous contaminants priority list and the generation of a number of reports on specific contaminants.

PRIORITY LIST

The priority list which currently is still in effect was established through a hazard rating checklist. Numerical scores on human health effects, non human biological effects, discharge to the environment and social and economic impact were established through a ministry survey.

SLIDE 9 The list has three categories: regulated hazardous compounds, potentially hazardous compounds, and surveillance compounds.

The first category, regulated hazardous compounds, are widely recognized as hazardous to the environment and public health based on existing scientific information. Ministry programs are underway to evaluate the effectiveness of guidelines and objectives set for these compounds.

SLIDE 10 This list contains eight compounds as listed on the slide. They are: asbestos, lead, mercury, polychlorinated biphenyls, vinyl chloride, DDT, polybrominated biphenyls, and mirex.

REVERSE 9 For the potentially hazardous compounds, there are insufficient data to determine the degree of hazard when released to the environment. There is however a definite cause for concern. The committee is primarily responsible for reviewing and recommending the strategy and program orientation to further assess the hazard of these priority compounds.

HAZARDOUS CONTAMINANTS PRIORITY LIST

- REGULATED HAZARDOUS COMPOUNDS
- POTENTIALLY HAZARDOUS COMPOUNDS
- SURVEILLANCE COMPOUNDS

<u>REGULATED</u> <u>HAZARDOUS</u> <u>COMPOUNDS</u>

- ASBESTOS
- LEAD
- MERCURY
- PCB s
- VINYL CHLORIDE
- DDT
- PBB's
- MIREX

The final group, <u>surveillance compounds</u>, do not represent undue hazard. However, their inherent toxicity is recognized, guidelines and objectives for discharge have been set in some cases and continued monitoring of these compounds is felt necessary. As additional scientific information becomes available further action may be necessary.

REPORTS

As noted previously, this committee produced a number of major reports as shown on the next slide. They are:

SLIDE 11

ENVIRONMENTAL ASPECTS OF SELECTED AROMATIC HYDROCARBONS IN ONTARIO

ENVIRONMENTAL ASPECTS OF SELECTED CHLORINATED HYDROCARBONS IN ONTARIO

POLYNUCLEAR AROMATIC HYDROCARBONS

ENVIRONMENTAL ASPECTS OF SELECTED AROMATIC AMINES AND AZO DYES IN ONTARIO

ENVIRONMENTAL ASPECTS OF RADIOACTIVE SUBSTANCES IN ONTARIO

In addition, summary reports on arsenic, cadmium, lead, mercury, asbestos   , were written.

- ENVIRONMENTAL ASPECTS OF SELECTED AROMATIC HYDROCARBONS IN ONTARIO

- ENVIRONMENTAL ASPECTS OF SELECTED CHLORINATED HYDROCARBONS IN ONTARIO

- POLYNUCLEAR AROMATIC HYDROCARBONS

- ENVIRONMENTAL ASPECTS OF SELECTED AROMATIC AMINES AND AZO DYES IN ONTARIO

- ENVIRONMENTAL ASPECTS OF RADIOACTIVE SUBSTANCES IN ONTARIO

HAZARDOUS CONTAMINANTS PROGRAM

HAZARDOUS CONTAMINANTS PROGRAM

SLIDE 12

In May 1980 the Ministry of the Environment established the Hazardous Contaminants Office of which I am the Co-Ordinator. The principal mandate of this office is to ensure the protection of the environment from the effects of hazardous contaminants. A simple statement but far from a simple task!

SLIDE 13

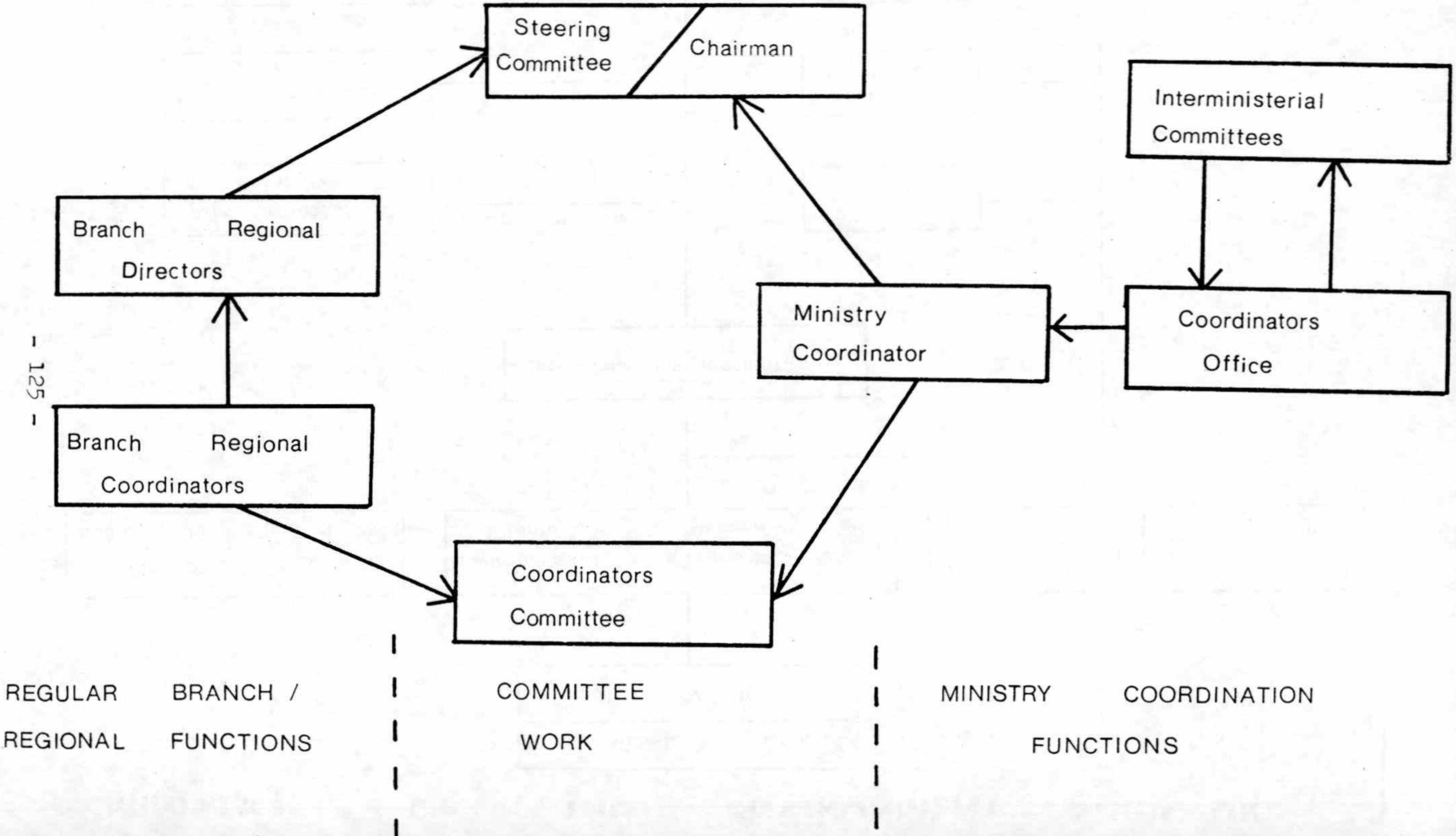
In terms of position in the Ministry management structure, this office is in the Resource Management Division and reports to the Executive Director.

SLIDE 14

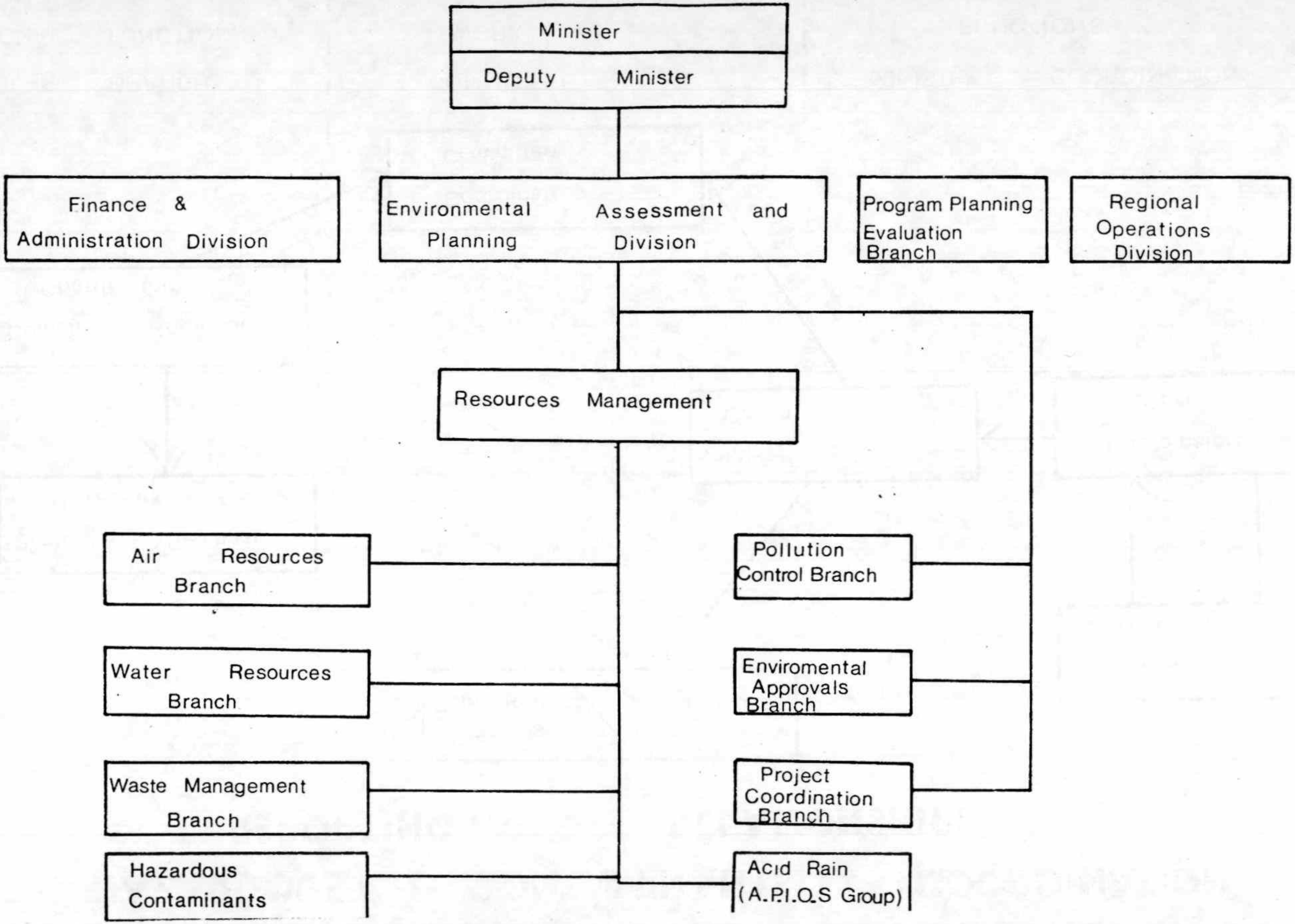
The following slide provides an overview of the hazardous contaminants structure. Basically there are two main committees: the Hazardous Contaminants Management Committee and the Hazardous Contaminants Co-Ordinators Committee and four co-ordination functions.

The Hazardous Contaminants Management Committee is represented by the appropriate regional and branch Directors and is chaired by the Executive Director of the Resource Management Division. The main function of this committee is to review matters raised by the Co-Ordinators Committee, to set the required policy and recommend approval of required resource allocation for the program on an annual basis.

HAZARDOUS CONTAMINANTS COORDINATION REPORTING RELATIONSHIPS



MINISTRY OF THE ENVIRONMENT STRUCTURE



The Hazardous Contaminants Co-Ordinators Committee is represented by a Co-Ordinator from each branch or region which has a role with respect to hazardous contaminants.

SLIDE 15

There are five branches and six regions represented and in addition there is a Co-Ordinator from the Pesticides Control Section and the Laboratory Services Branch.

SLIDE 16

The objectives of this committee are:

- To improve the Ministry's ability to deal with hazardous contaminants through MBR planning.

- To improve overall program efficiency.

- To exchange pertinent information and assist in resolving interbranch questions of jurisdiction and responsibility related to hazardous contaminants.

These encompassing objectives should give you an indication of the scope of this committee.

HAZARDOUS CONTAMINANTS CO-ORDINATORS

COMMITTEE REPRESENTATION

BRANCH	REGION
AIR RESOURCES	CENTRAL REGION
WATER RESOURCES	WEST CENTRAL REGION
POLLUTION CONTROL	SOUTHWEST REGION
WASTE MANAGEMENT	SOUTHEAST REGION
ENVIRONMENTAL APPROVALS	NORTHWEST REGION
PESTICIDES SECTION	NORTHEAST REGION
	LABORATORY SERVICES

CO-ORDINATORS COMMITTEE OBJECTIVES

- TO IMPROVE THE MINISTRY'S ABILITY TO DEAL WITH HAZARDOUS CONTAMINANTS THROUGH MBR PLANNING.

- TO IMPROVE OVERALL PROGRAM EFFICIENCY.

- TO EXCHANGE PERTINENT INFORMATION, ASSIST IN RESOLVING INTERBRANCH QUESTIONS OF JURISDICTION AND RESPONSIBILITY RELATED TO HAZARDOUS CONTAMINANTS.

SLIDE 17

Planned objectives for the 1981-1982 fiscal year are:

(1) To establish a strategy for the management and control of hazardous substances in Ontario of which I will go into more detail later.

(2) To establish reporting procedures for the Ministry dollars spent related to hazardous contaminants (1980-1981 - $4.5 million).

(3) To establish a funding mechanism for research grants.

(4) To promote liaison with other organizations and strengthen existing ties.

HAZARDOUS CONTAMINANTS OFFICE

1981 - 82 CONTAMINANTS

---

(1) TO ESTABLISH A STRATEGY FOR THE MANAGEMENT AND CONTROL OF HAZARDOUS SUBSTANCES IN ONTARIO.

(2) TO ESTABLISH A REPORTING PROCEDURE FOR THE MINISTRY DOLLARS SPENT RELATED TO HAZARDOUS CONTAMINANTS.

(3) TO ESTABLISH A FUNDING MECHANISM FOR RESEARCH GRANTS.

(4) TO PROMOTE LIAISON WITH OTHER ORGANIZATIONS AND STRENGTHEN EXISTING TIES.

STRATEGY FOR THE MANAGEMENT AND CONTROL OF HAZARDOUS SUBSTANCES

I would now like to discuss the strategy for the management and control of hazardous substances. The Hazardous Contaminants Office is currently developing a Hazardous Substance Framework for the management and control of hazardous substances in Ontario. We are currently reviewing various schemes and frameworks, proposed by EPA, various U.S. States, OECD and the I.J.C. (Organization for Economic and Co-Operative Development and the International Joint Commission).

The list will be developed through consultation with recognized experts. Before I discuss an overall flow scheme, a few definitions are in order so that we may all speak the same language.

SLIDE 18

TOXICITY is a basic biological property of a substance or its innate ability to harm.

HAZARD is the ability of a substance to cause harmful effects. I should stress that this is a combination of toxicity and exposure.

RISK is the probability that an effect will take place - this is usually in terms of an unfortunate outcome (mortality).

TOXICITY	IS A BASIC BIOLOGICAL PROPERTY OF A SUBSTANCE OR ITS INNATE ABILITY TO HARM.
HAZARD	IS THE ABILITY OF A SUBSTANCE TO CAUSE HARMFUL EFFECTS. = TOXICITY + EXPOSURE
RISK	IS THE PROBABILITY THAT AN EFFECT WILL TAKE PLACE - THIS IS USUALLY IN TERMS OF AN UNFORTUNATE OUTCOME (MORTALITY).

SLIDE
19

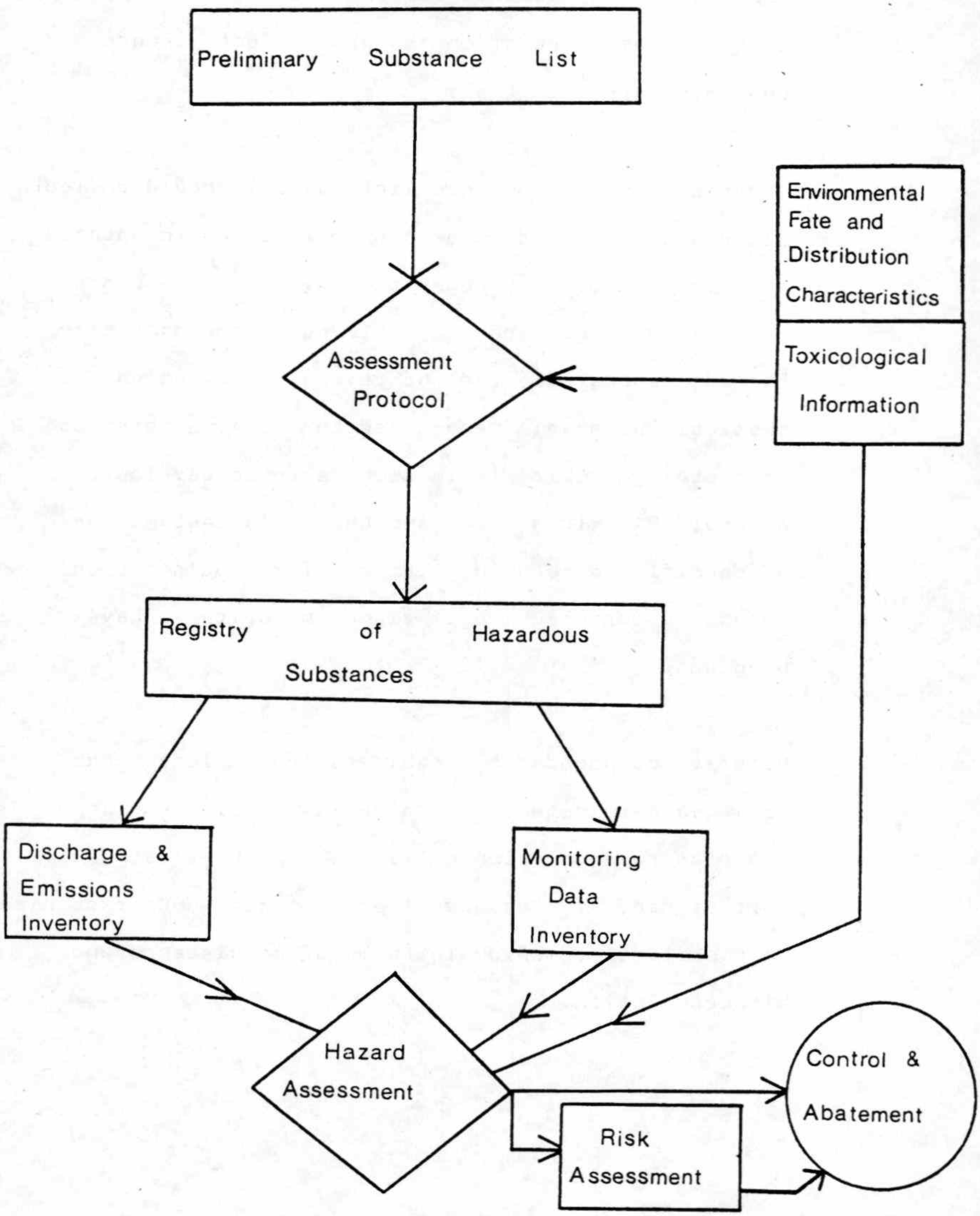
The basic outline for a hazardous substance framework is shown on the slide in modular form. Each module encompasses a large area and requires further differentiation before a definitive strategy can be established.

The entire process can be considered as an early warning system for hazardous contaminants, allowing control and abatement to be developed on a planned basis rather than on an ad-hoc basis.

The basic framework is indicated by the establishment of a preliminary substance list - this is an essential point at which to start the program. Using this list, data on the characteristics, fate, and distribution together with toxicological data, will provide a preliminary assessment and permit the development of a registry of hazardous substances.

Monitoring and discharge data relative to these chemicals will then allow a hazard assessment from which a risk assessment can be established which would lead to controls and abatement. Although not indicated on the slide a line should be drawn from controls and abatement back to the monitoring and emission inventories so as to evaluate the program.

STRATEGY FOR THE MANAGEMENT CONTROL OF HAZARDOUS SUBSTANCES IN ONTARIO



PRELIMINARY SUBSTANCE LIST

The preliminary list is currently being developed by a sub committee of the Hazardous Contaminants Co-Ordinators Committee.

The preliminary substance list ideally should reflect all substances used, produced or imported in Ontario that potentially may enter the environment. Since not all substances can be reviewed at the same time the substances selected for review would include chemicals with well recognized toxicity, substances from other priority lists such as those developed by EPS, EPA, NIOSH, etc. and chemicals that may be of specific concern in Ontario. This would include compounds for which regulations and criteria have been set.

Priority compounds for consideration include human positive carcinogens and potential carcinogens in addition to those already flagged in the first list. Furthermore, it includes important compounds recognized in a particular medium in terms of persistence and bioaccumulation.

ENVIRONMENTAL ASSESSMENT PROTOCOL

Substances from the preliminary list would be assessed in terms of toxicological parameters and environmental and fate distribution characteristics. It should be noted that exposure is not a factor in this assessment.

REGISTRY OF HAZARDOUS SUBSTANCES

This registry would be a base for determining allocation of resources in terms of industrial use, discharge and emission data and in terms of environmental monitoring programs. This registry could give rise to a mandatory reporting procedure for industry to provide discharge and emission data as in the case of Michigan State.

I would like to emphasize that the strategy this Province is developing would not be limited to a specific media but would encompass all emissions or discharges to the environment.

I would like to briefly discuss the Michigan hazard assessment process to give some indication of the parameters used in rating chemicals.

SLIDE 20

The next slide shows the seven factors that are considered. They are:

1) acute toxicity

2) carcinogenicity

3) mutagenicity

4) teratogenicity

5) persistence

6) bioaccumulation, and

7) other adverse effects which include acute and chronic effects to terrestrial and aquatic life, phytotoxicological effects and aesthetics.

Each category has been assigned a point value which reflects its level of environmental concern. A score of seven in any one category or a cumulative score of seven or more points will place the chemical on the CMR (Critical Materials Register).

MICHIGAN MATERIALS REGISTER HAZARD

ASSESSMENT SHEET

I. ACUTE TOXICITY

II. CARCINOGENICITY

SCORE	CATEGORY
7	HUMAN POSITIVE POTENTIAL HUMAN ANIMAL POSITIVE
3	POTENTIAL ANIMAL
2	CARCINOGENIC BY A ROUTE OTHER THAN ORAL OR DERMAL STRONGLY SUSPECT CARCINOGEN BY ACCEPTED MUTAGENICITY SCREENING TESTS
1	SUSPECT CARCINOGEN BY ACCEPTED MUTAGENICITY SCREENING TESTS
0	NOT CARCINOGENIC
	INSUFFICIENT INFORMATION

III. MUTAGENICITY

IV. TERATOGENICITY

V. PERSISTENCE

VI. BIOACCUMULATION

VII. OTHER ADVERSE EFFECTS

A. TERRESTRIAL AND AQUATIC

B. PLANT

C. AESTHETICS

For example on the slide I have expanded the carcinogenicity category. If the chemical has been demonstrated to be a human positive, potential human or animal positive carcinogen, then it would receive a score of seven points placing it on the CMR. In this assessment the terminology applied is strictly defined and all assessments are made from the original publications, not summary reports. This helps to ensure the integrity and objectivity of the program.

SLIDE

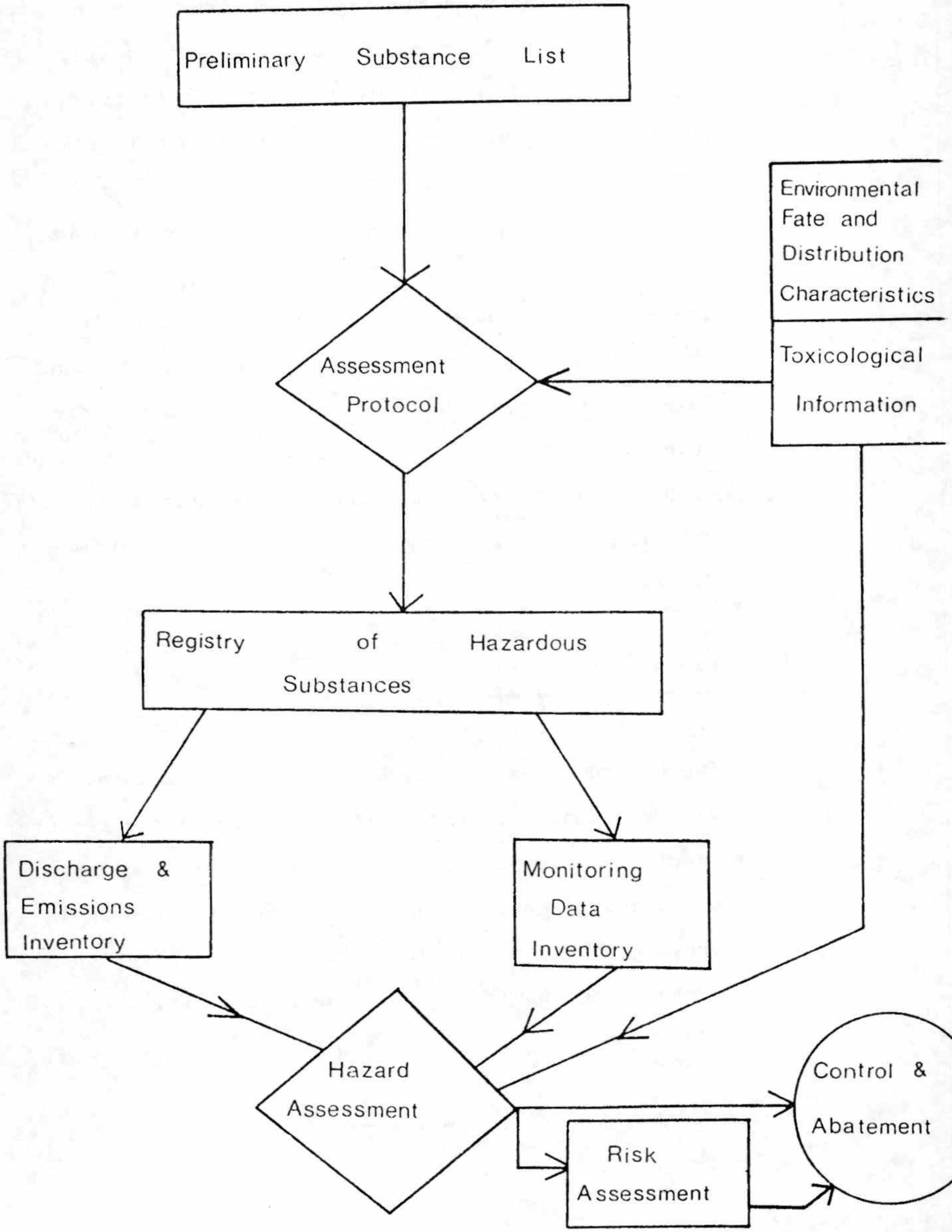
INVENTORY

19 A

Two inventories are depicted in the slide - an industrial emissions discharge inventory and a monitoring inventory.

The first inventory known as the Hazardous Contaminants Inventory System or HCIS was developed by the Ministry to maintain an overall mass balance on substances used in the province on an industry-by-industry basis.

STRATEGY FOR THE MANAGEMENT CONTROL OF HAZARDOUS SUBSTANCES IN ONTARIO



The data includes yearly quantities used, stored and produced and the yearly quantity lost to air, water or land. This information would ascertain whether any substances are entering or are likely to enter the environment in quantities that may constitute a danger to human health or environment.

The monitoring inventory would provide a check on the state of the environment. Providing background levels and an early indication if these levels are changing, this inventory together with the discharge/ emission inventory, would provide the Ontario specific data required for this early environmental warning system.

HAZARD ASSESSMENT

The hazard assessment is based on exposure data. With a suitable inventory the exposure of the receptor population may be modelled from available monitoring or discharge/emission data. Such a procedure would provide "above the Ontario Average" concentration contours and would target areas of concern.

RISK ASSESSMENT

Scientifically we can determine risk to a population, however, to define a level of acceptable risk is a non-scientific exercise and depends on the political and social sitation. This makes it very difficult to ascertain an acceptable level.

CONTROLS & ABATEMENT

If a substance is assessed as being harmful to human health or the environment, suitable control and abatement procedures would need to be developed. This would in turn be evaluated through the two inventory systems.

HAZARDOUS CONTAMINANTS OFFICE

SLIDE 21

The last thought I want to leave you with is what this office can do for you. As the chief Ministry liaison for hazardous contaminants, the Hazardous Contaminants Office can provide you with:

- status on hazardous substances in terms of any Ministry guidelines and regulations

- data on current Ministry programs

- provide any Ministry background documents or reports on hazardous contaminants

- the name and area of expertise of Ministry specialists

- bibliographies on hazardous contaminants

HAZARDOUS CONTAMINANTS OFFICE

EXTERNAL LIAISON

- PROVIDE INFORMATION ON THE STATUS OF HAZARDOUS SUBSTANCES IN TERMS OF MINISTRY GUIDELINES OR REGULATIONS

- DATA ON CURRENT MINISTRY PROGRAMS

- PROVIDE ANY MINISTRY BACKGROUND DOCUMENTS ON HAZARDOUS CONTAMINANTS

- TIE YOU INTO THE CORRECT MINISTRY SPECIALIST

- BIBILIOGRAPHIES ON HAZARDOUS CONTAMINANTS

Hazardous Contaminants Office

It is the function of the Hazardous Contaminants Office, through the Co-Ordinator, to ensure that the program components are in phase and are effectively developed. In addition, the office represents a focal point for external interaction with other agencies and organizations.

Current commitments include representation on two inter-ministerial committees - Environmental Health Committee and Health Hazards of Building Materials Committee; representation on the Toxic Substances Committee of I.J.C., Ad Hoc Federal Dioxin Committee, Transportation of Dangerous Goods, liaison with other committees such as the intergovernmental Niagara River Study.

In terms of funding and staffing, this office has a complement of three and a total operating budget of $344K.

Existing Programs

The major hazardous contaminants programs presently underway within the Ministry are:

1) PCB disposal via the plasma arc

2) PCB disposal via the SJT engine

3) Ontario Sports Fish program

4) Young of the Year Fish Studies

5) Effects of Various Organic compounds on the aquatic environment

6) Measurement of trace organic contaminants from incinerators

7) Measurement of the air from hazardous contaminants

8) Characterization of airborne particulate matter

9) St. Lawrence River Study

10) Niagara River Study

11) Development of the Dioxin Laboratory and the required protocols

12) Characterization of industrial wastes

13) Assessment of Drinking Water for hazardous contaminants

One other major program is in the determination of the genotoxicity of certain effluents. The Laboratory Services Branch is developing a battery of tests to evaluate the chemicals that may have the ability to damage genetic material.

SLIDE 16 A

The battery of tests will include the AMES Test for mutation - two DNA damage in bacteria and two tissue culture systems to show chromosome damage and to support the AMES test.

The AMES test - is a good indication of a primary nature however it is not to be used alone in screening tests for hazardous chemicals - other tests must be carried out to support the findings of the AMES test.

The AMES test must demonstrate a dose related increase in mutations. The number must be significantly higher than the control.

The bacteria are subjected to the chemical and allowed time to colonize. The number of colonies must increase as the dose increases and it must be by a significant amount.

Finally, in order to prevent scenes such as these slides .... we must learn to identify and control (slide) the chemicals in our environment and thus be able to protect society (slide). This is a task that requires the input of many disciplines and the understanding of the real risks involved.

PROTECTING NEW YORK STATE WATERS FROM TOXIC POLLUTION

by

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New York State Department of Environmental Conservation

New York State has extensive and varied surface water resources consisting of 113,000 kilometers of streams and rivers, 4,000 lakes with a total of 3,000 square kilometers of surface area, plus 3,200 kilometers of marine coastline on the Atlantic Ocean and Long Island Sound and 1,000 kilometers of coastline on Lakes Erie and Ontario. A map of the lake, river, and coastal system of New York is shown in Figure 1. In addition New York State has extensive potable groundwater resources, particularly in the Mohawk and Susquehanna River basins and under all of Long Island.

As one of the major industrial and commercial states in the United States, New York generates waste material which historically has found its way into its waters. In the mid-1960's New York, without federal mandates or financial support, began a stepped-up pollution control program to bring life back to its heavily polluted rivers and to protect clean water from further degradation. Since that time both industrial and municipal sewage treatment plants have been built on most of our impacted waterbodies. The results today are apparent with increased fishing, bathing, and drinking water supply possibilities. For example, the cleanup on the Hudson River has reopened more than thirty-five miles of river above Hudson to anadromous fishes and their associated fisheries. Striped bass, American shad, blueback herring and alewife, as well as the endangered shortnose sturgeon now migrate each year as far as Troy Dam and, in the future, their migrations may extend even further up the Hudson River as well as the Mohawk River as a result of the abatement program.

The success of the pollution control efforts of the 1960's and 1970's has dramatically revealed the further problem of toxic chemicals which are concentrating in the flesh of the fish that are coming back into our lakes and rivers. Many of these chemicals are potentially hazardous to man and wildlife and they are now at the focus of our pollution control efforts. The problem of toxic chemicals is particularly acute in New York. The State is tied for fourth place with Louisiana and Ohio in amount of chemical manufacturing and many of these chemicals have been the persistent pesticides and the feed stocks from which these chemicals are manufactured. Much of this manufacture occurred before society's current concern with toxics and as a consequence the waste from these industries has been widely distributed in dumps and river and lake sediments and biota.

Fig. 2 shows the major metropolitan areas of the State superimposed on the surface water system. These metropolitan areas are also the focal point for most of our industrial and commercial activity which has potential for the generation of toxic chemical wastes. As one might expect, this map reveals where most of our major toxics problems exist. There are five regions of prime concern: the Niagara River, Lake Ontario, the Hudson-Mohawk basin, the Susquehanna River near Binghamton, and Long Island (Fig. 3). One further concern, not apparent from Fig. 2 are the high elevation lakes in the northeast part of the State where fish populations have been eliminated by increased acidity associated with airborne pollution.

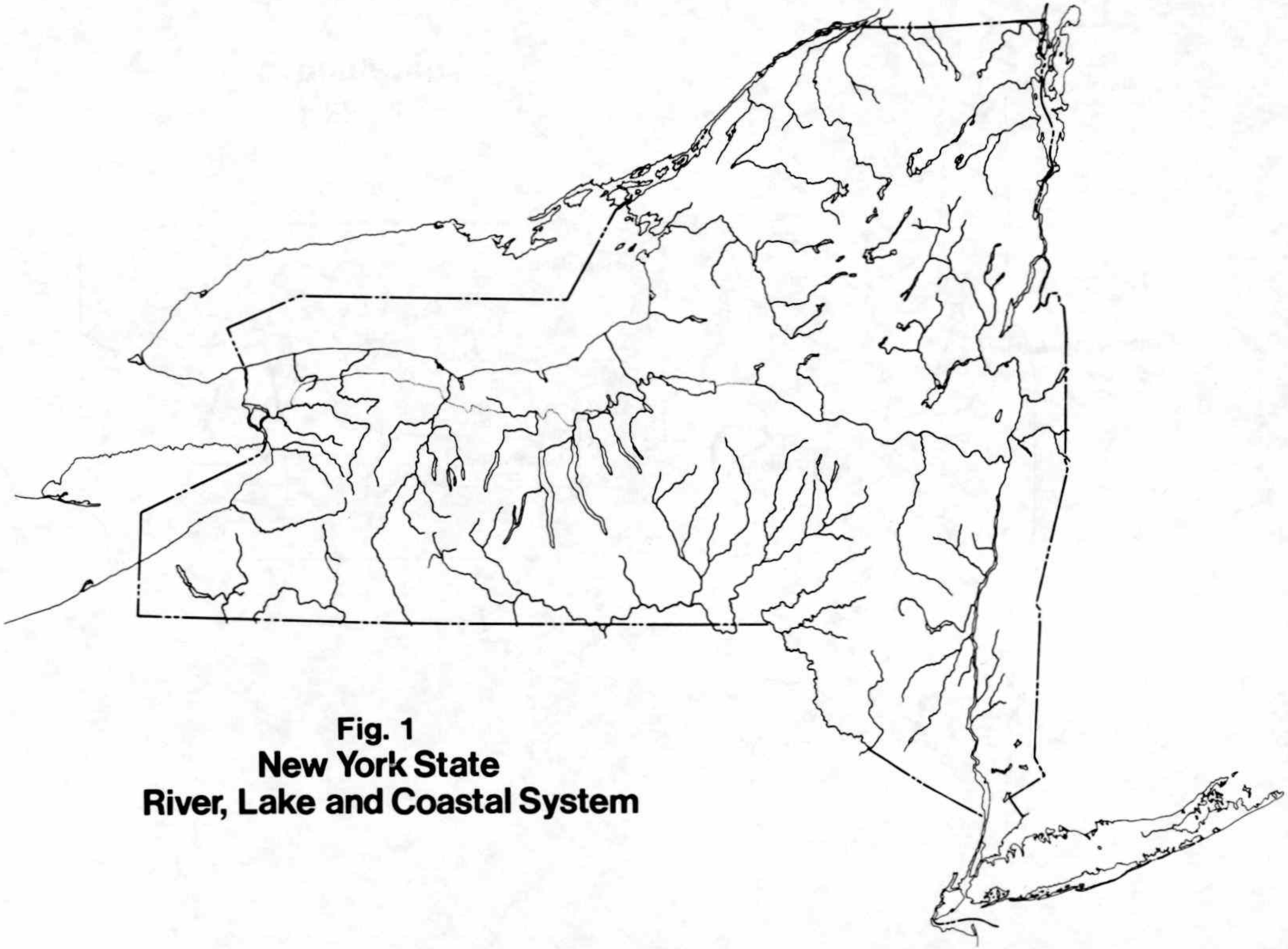


Fig. 1
New York State
River, Lake and Coastal System

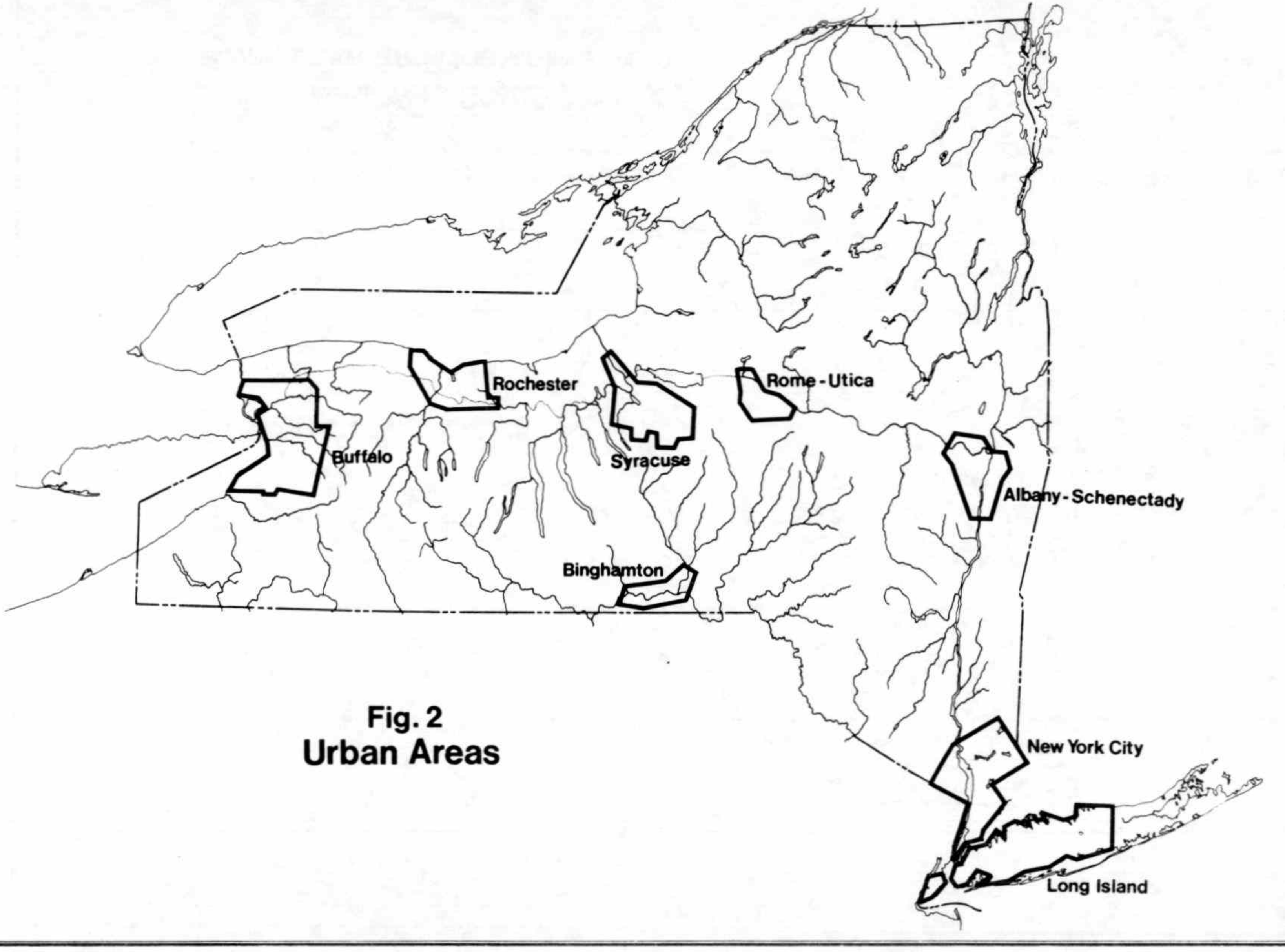


Fig. 2
Urban Areas

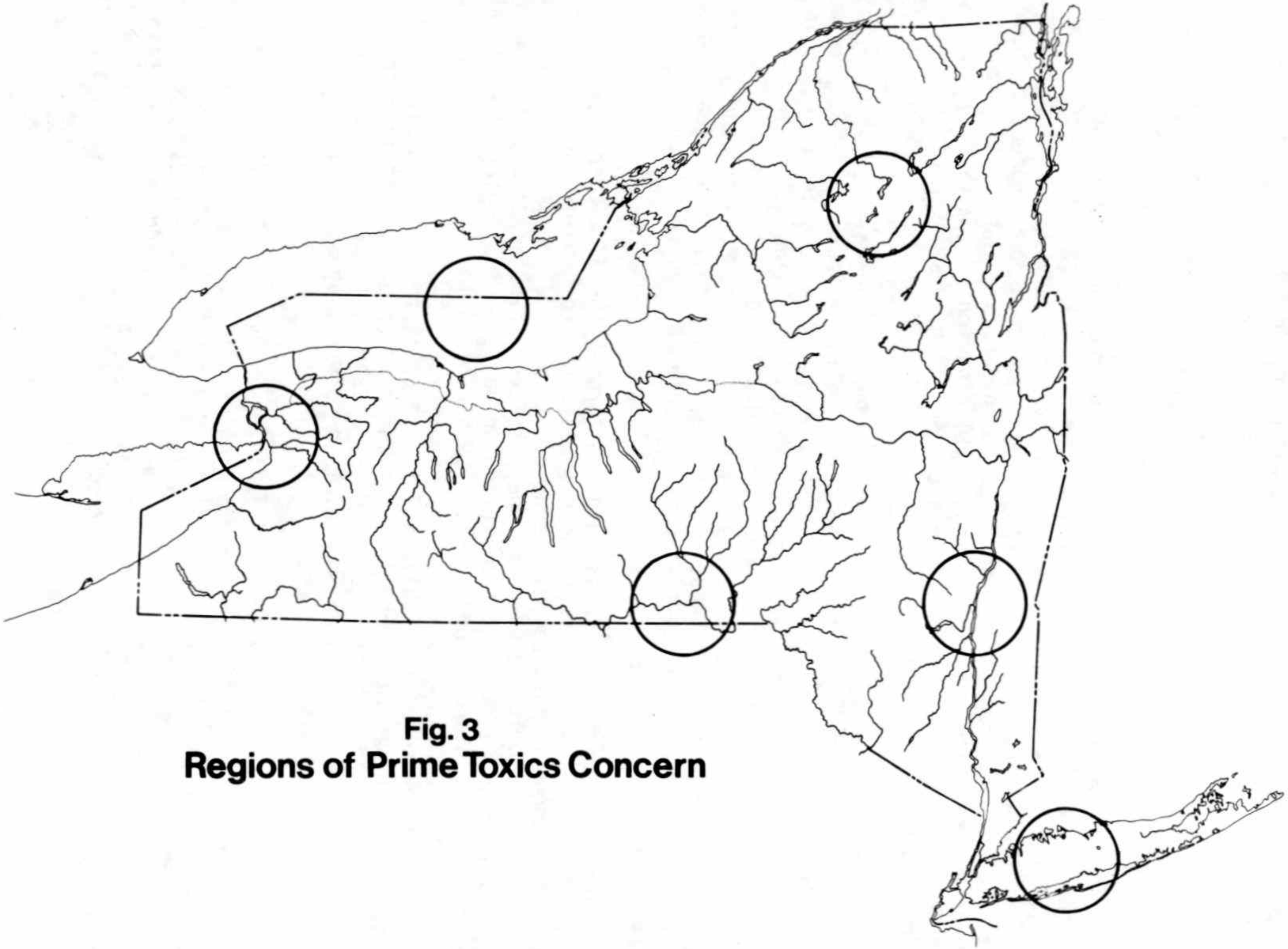


Fig. 3
Regions of Prime Toxics Concern

An overview of toxics problems in New York State was compiled in 1978 (1) and a more recent survey of toxics problems in New York was published in 1980 (2).

THE BASIC TOOLS FOR TOXICS CONTROL

New York State has fashioned a number of information, control, and monitoring tools into an integrated toxics strategy. The key parts of the strategy are: a survey of industrial chemicals used in the State; a survey of hazardous waste sites; a Statewide fish-flesh monitoring program; a trackdown process to identify pollution sources; a program tc assess the human, animal, and aquatic impacts of chemicals; the State Pollution Discharge Elimination System (SPDES) permits; and laboratory services. All of these are undergoing constant modification as new information and resources become available.

The Industrial Chemical Survey. In 1976 New York began a survey of organic chemicals used, produced, stored, distributed, or otherwise disposed, by industry (3). The initial inventory was based on a questionnaire returned by 4,116 industries reporting chemical use over the previous 7 years. As the questionnaires were received, industries of special concern were identified on the basis of type and amount of chemicals used and multi-disciplinary (air, water, pesticides, hazardous waste) inspections were carried out by DEC field staff to identify real and potential leaks of these chemicals to the environment. Some 38 industries have been inspected under this program to date.

The survey is continually being updated through the SPDES permit renewal process for direct dischargers and through the pretreatment program for indirect dischargers. The chemicals covered are also being expanded to include inorganics. The survey results have been computerized and may be retrieved in numerous ways including by drainage basin. As an example, the average annual use of a typical industrial chemical, 1,1,1-trichloroethane, is shown by sub-basin in Fig. 4.

This major source of chemical use information is now being supplemented by attempts to include important chemical use information outside of industry. As an example we have nearly completed a survey of agricultural pesticide use by county that should be particularly helpful in identifying and controlling groundwater contamination problems in rural areas.

The Hazardous Waste Site Survey. In 1979 a survey of all sites in the State suspected to contain hazardous waste was completed (4). With input from counties this survey was updated in 1980 (5). It now reveals 852 separate disposal areas on 680 properties that are known or suspected to contain hazardous wastes. These sites have been classified according to our state of knowledge and the state of remedial action at each site. On 20% of the sites, only preliminary data are available and further inspection is needed to verify that a problem exists. The

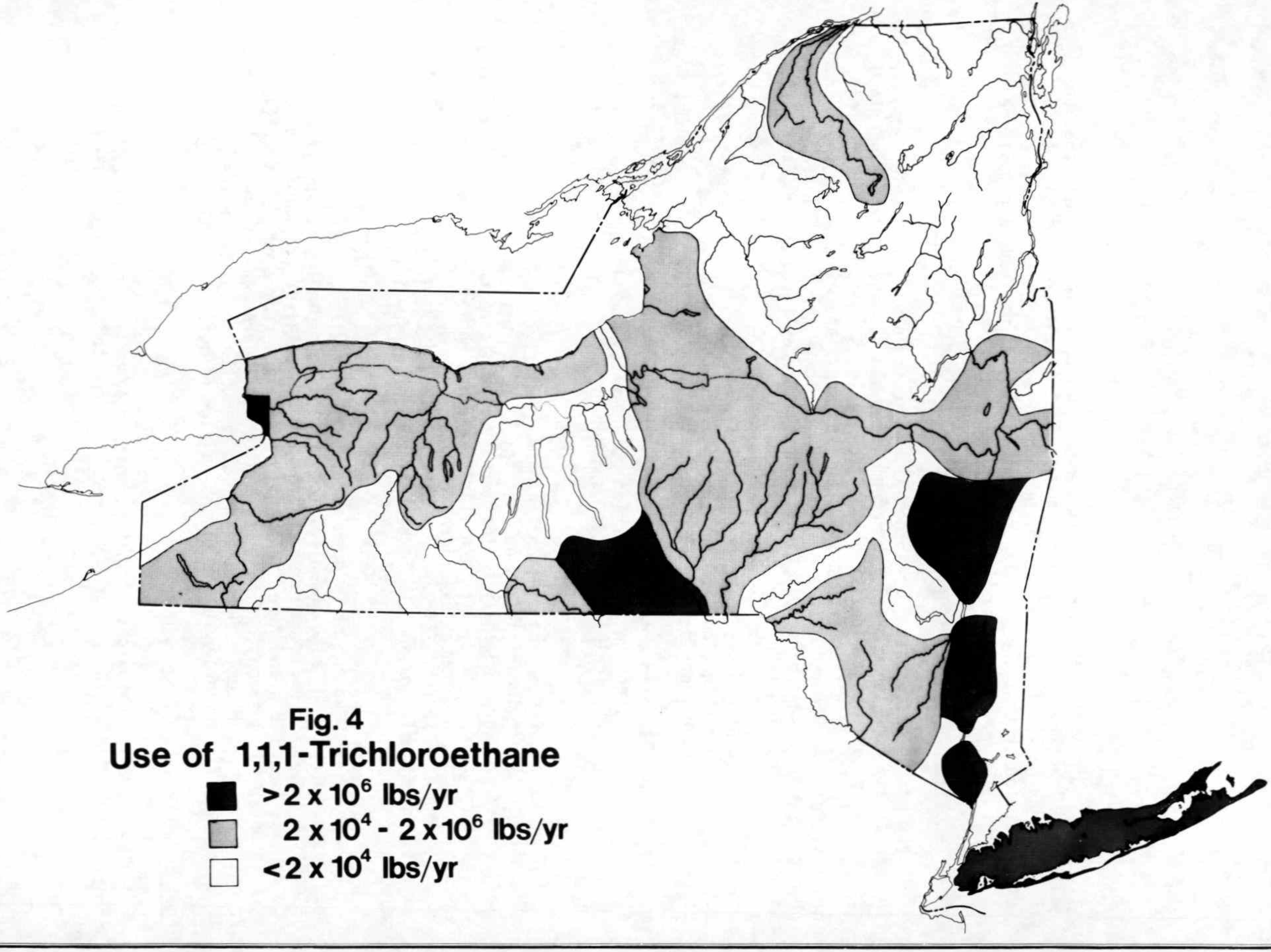


Fig. 4
Use of 1,1,1-Trichloroethane

- $> 2 \times 10^6$ lbs/yr
- 2×10^4 - 2×10^6 lbs/yr
- $< 2 \times 10^4$ lbs/yr

site list and classification are being used to guide systematic investigation and remedial activities that will ultimately lead to either a decision that the site has no significant amount of hazardous waste and hence requires no further action or that the site is properly closed, maintained, and monitored.

Statewide Fish Monitoring Program

Many of the halogenated pesticides as well as halogenated organic compounds in general and some toxic metals are accumulated and concentrated in fish flesh. The resulting toxic contamination in the fish reflects the presence of the toxic substance in the fish's environment (water, sediment, and biota) over the course of its life. Because the fish are able to concentrate toxic substances, these chemicals when present at very low environmental concentrations are often easier to detect in the fish than they are in the water.

The purpose of the Statewide Fish Monitoring Program is to systematically monitor selected combinations of fish species in the major waterways of New York State for the occurrence, magnitude, and significance of selected toxic substances. The information is used to locate areas of specific toxic chemical concern and monitor the levels of toxics in sport and commercial fish. It has also provided data for long-term trend analyses carried out recently (6) which showed decreases in levels of some chemicals (DDT, PCBs, and Mercury) in fish flesh from certain parts of the State.

About 100 fish sampling stations have been selected through the State for this effort. Their location is shown on Fig. 5. Fish are collected from each station every 3 years and analyzed for mercury, lead, cadmium, chromium, arsenic, DDT, mirex, PCB, chlordane, aldrin/dieldrin, endrin, heptachlor, heptachlor epoxide, lindane, and other hexachlorocyclohexane isomers. As information is received from the SPDES permit program, the Industrial Chemical Survey, or other sources, additional substances will be analyzed for at specific sites as resources permit.

There are a number of other special fish flesh monitoring projects that have been carried out by the Fish and Wildlife Division to provide more specific information on toxic pollutants. Fish from the Hudson River are monitored for PCB's while both PCB's and mirex are monitored in fish from a number of stations in Lake Ontario. A synoptic fish flesh monitoring program was carried out in Lake Erie and a survey of toxic chemicals in fish from urban areas where the Department is developing fishery programs has also been carried out.

Trackdown

Once there is an indication that an abnormally high level of toxic material exists or has existed in a water body (possibly from the results of a fish flesh

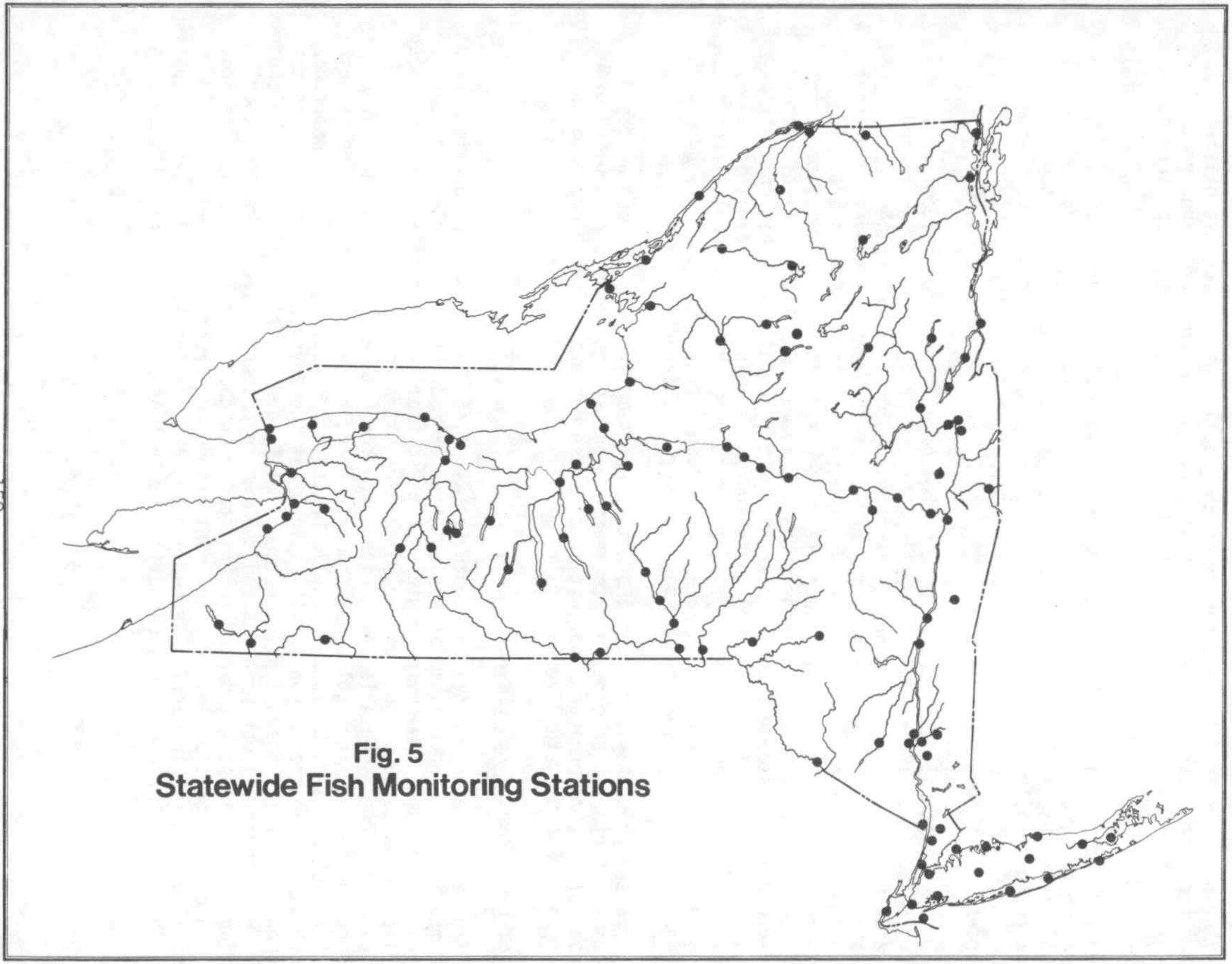


Fig. 5
Statewide Fish Monitoring Stations

monitoring programs) then the source of this pollutant must be established. Since the fish flesh program provides information on long-term exposure to a toxic substance a necessary step is to determine whether the substance is still present in the water body.

This has usually been done by another biological monitoring procedure based on chemically analyzing natural macroinvertebrate populations, or populations suspended in the water on synthetic substrates for substances of concern. Analysis of these macroinvertebrate colonies at various places in a stream or river can give valuable information to pinpoint active pollution sources.

Many toxic materials concentrate in bottom or suspended sediments where they are bound to the surface of small particles or dissolved in entrapped organic matter. As with biological systems, sediments often concentrate organic chemicals and some metals to concentrations many thousand-fold greater than the concentration in the surrounding water. Since sediments are laid down over the life-time of the water body they serve to give a complete history of the presence of some toxic substances in the water. By using fish, macroinvertebrate and sediment analyses together it is usually possible to quickly locate the source of input of the toxic substance. The source can then be verified by sampling the plant effluent directly or by taking samples from soils, lagoons, or storage areas. We have found these techniques useful on the Hudson, Oswego, and Grasse Rivers and on some smaller creeks and lakes.

We are presently experimenting with other sampling methods such as caged clams and synthetic absorption mats that can be used to integrate sampling over a controlled time period. Application of these methods is being explored on the Hudson and Niagara Rivers.

Inter-Departmental Assessment

Once information shows that a toxic situation exists and its location, extent and magnitude are known some assessment must be made of the importance of the situation to human and environmental health so that the appropriate resources can be applied to control, correct, or manage the situation. Responsibility for assessing health impacts is split within New York State. The Department of Health has responsibility for public health matters and hence for assessing the impact of toxic chemical situations on public health. The Department of Environmental Conservation has the responsibility to protect the environment and hence has the responsibility for assessing impact on wildlife and aquatic health. This dichotomy follows through all our programs and the two departments have worked together to fashion an assessment procedure that calls on the expertise both possess in the human and aquatic fields. The joint assessment process is used in writing discharge permits, in developing surface and groundwater standards, and in reacting to findings of toxic chemical situations of past or present origin. Its success

depends on two government agencies working cooperatively at both the executive and staff levels.

The Discharge Permit System

The basic tool for controlling on-going release of toxic chemicals to the environment is the State Pollution Discharge Elimination System (SPDES) permit. Although the system was delegated to the State by the federal government the State system departs from the federal system in being applicable to groundwater as well as surface water discharges. The federal system is only applicable to surface water discharges.

The first round permits under this system were issued in the mid-1970's and did not include references to specific toxic chemicals. However, these chemicals are being addressed under the second or renewal round that is currently underway.

The SPDES permits are not particularly effective for controlling groundwater contamination by landfills and dumps and we now rely more on facility permitting, to ensure proper construction and maintenance, again under a federal program delegated to the State.

Laboratory Services

Good laboratories are key to any toxics control program. They require technical skills that are scarce and in great demand today. Analyses on fish flesh are conducted by our Department laboratories but water and sediments are analysed by a laboratory in the Department of Health. Both laboratories contain highly competent scientists and produce results of high quality. Unfortunately they are overloaded with work and we have been forced to obtain services from commercial laboratories.

To assure that laboratory resource needs are used where they can be most valuable and to ensure proper coordination between laboratory and field personnel, a laboratory coordination unit has been established within the Department. One of its important functions is to assign analysis priorities to samples before they are collected. These priorities then determine the order of analysis of the samples. As might be expected, the lowest priority samples rarely get analyzed. This has resulted in a much higher level of thought and preparation in the field sampling program than has previously been the case.

To cut down to some degree on the drain on expensive laboratory resources we have undertaken a 3 year program under a cooperative agreement with EPA to develop and evaluate the use of screening test that will determine the presence of classes of substances in environmental samples. Classes that we have worked on to date include mutagens, halogenated organics, polycyclic aromatic hydrocarbons, and

dioxin-like material. Results are promising for the application of some of these screening tests but it will be another year at least before we can be certain of how they will fit into our ongoing programs.

Biomonitoring techniques are also being developed and tested on industrial and municipal effluent streams and undoubtedly will play an important role in the future.

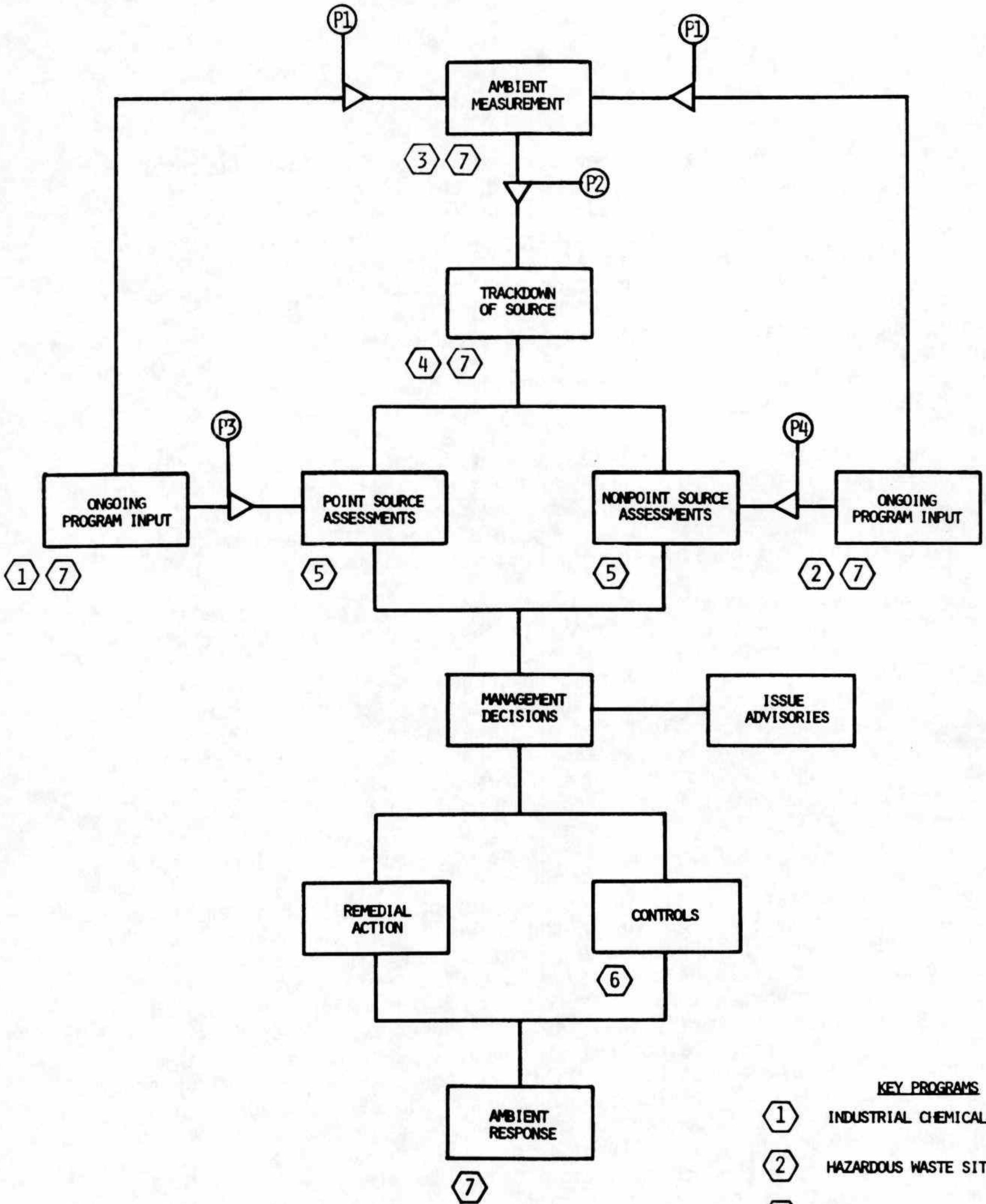
THE TOXICS CONTROL STRATEGY

The programs described in the previous section along with many more that are parts of other Department programs have been integrated into an overall working strategy to manage toxic substances problems. New York has no bureaucratic structure specifically devoted to overall toxic substances control and coordination. Rather there is general agreement on the toxics strategy at the executive level and close working arrangements at the staff level. This strategy has been used and modified as appropriate on such environmental tragedies as the mirex contamination of L. Ontario, the massive PCB contamination of the Hudson River, and Love Canal.

This overall toxics strategy is illustrated in Fig. 6. The important activities and where the key programs discussed earlier fit into this strategy are shown. The top box represents activities connected with interrogation of the environment that include monitoring to identify specific problem areas as well as to determine changes that reflect the ambient response to remedial and control activities represented in the bottom box. For surface waters we have relied heavily on the Statewide Fish Monitoring Program but we will be supplementing this in the near future with an expanded emphasis on measurement of toxics in the water column itself. These monitoring programs obtain input into sampling locations and parameters for analysis from numerous ongoing programs in our Department and the Department of Health. For groundwaters we have as yet no systematic monitoring established on a Statewide basis. For groundwater information we rely on analyses of water supply wells, primarily for volatile halogenated hydrocarbons, carried out on an ad hoc basis by the Department of Health and local governments.

A toxic situation identified by ambient monitoring must be tracked down to its source and, in particular, information must be obtained to determine whether the source is on-going or not. The trackdown program described in the previous section is the tool used for surface water situations. For toxic situations in groundwater we are gradually gaining experience with source trackdown through well boring and subsequent chemical analyses of water and soil coupled with thorough site investigations.

It it is possible to pinpoint one or a few potential sources for the contamination, the trackdown is usually successful. This was shown for a trackdown of a mirex



KEY PROGRAMS

1 INDUSTRIAL CHEMICAL SURVEY

2 HAZARDOUS WASTE SITE SURVEY

3 STATEWIDE FISH MONITORING

4 TRACKDOWN

5 INTER-DEPARTMENT ASSESSMENT

6 SPDES PERMITS

7 LABORATORY SERVICES

FIG. 6. OVERALL TOXICS STRATEGY

⬡ KEY PROGRAMS

◯ PRIORITY SETTING INPUTS

source in the Oswego River where an industry was found from the Industrial Chemical Survey that had used a small amount of this chemical in an experimental program. Sampling of sediments up and downstream of the industry revealed the source. In a recently completed groundwater contamination trackdown in the Binghamton area, a prime suspect was located using SPDES and Industrial Chemical Survey information and the source was subsequently verified by direct groundwater analyses using in-place wells supplemented by a few additional borings. The trackdown of a groundwater contamination incident in the Village of Brewster has not yet been successful in identifying the source. In this case, neither the Industrial Chemical Survey nor SPDES files revealed any prime suspects.

Once the source has been identified, either through the trackdown process or through regular program inputs, an assessment of public health and environmental impacts is carried out as described in the previous section. The pathway of the chemical in the environment and all possible effects of the chemical must be considered so that rational management decisions can be made.

In general there are three different directions that can be taken to react to or prevent a toxic chemical situation. If the source is ongoing, control measures can be instituted especially through the permit processes. If the problem arises from a past action that is no longer taking place remedial measures of some kind may be possible, such as dredging to remove a contaminated sediment. If there has been a violation of State water quality standards administrative or legal action can be taken to require cleanup or compensation by the responsible party. This procedure was used to handle the problem caused by contamination of the Hudson River with PCBs from capacitor plants at Fort Edwards and Hudson Falls (7). In some cases it will be necessary to issue health advisories to the public, and this may often be the only practical response.

After the appropriate remedial or control actions have been taken, a change in the ambient environment would be expected to occur. If the source had been correctly identified and the appropriate remedial or control methods have been used one would expect this to be a decrease in environmental levels of chemical contaminants. It is important that measurements on the ambient environment be made (first box, Fig. 6) to verify that there is indeed a decrease in the environmental level and that the control or remedial measures are effective. Remedial actions themselves must be carefully monitored while they are underway because planned actions are not always implemented successfully. One example of this was a very heavy cadmium contamination in the sediments of a cove on the lower Hudson River caused by effluent from a battery manufacture. Dredging was carried out to remove the contamination, but after dredging the surface of the sediment had about the same concentration of cadmium as before the dredging.

This describes the overall concept of how the toxics control strategy operates. However, there is a missing ingredient and that is some control over

the strategy itself. There must be something that will keep the strategy from chasing will-of-the-wisps and force it to concentrate on the important problems. In a government agency this is often difficult to structure since there are driving forces that arise from scientific considerations and driving forces that arise from political considerations and although sometimes they overlap in many cases they do not. In any case, the strategy must be responsive to both the scientific and political realities. There are four points designated by P on Fig. 6 where such controls are being exerted. Three of these P1, P3, P4, are primarily chemical specific while P2 is site specific.

We have completed a review of all chemicals reported in the Industrial Chemical Survey to determine those chemicals which should be of highest priority for our various programs (8). Some 6,000 chemicals are listed in the survey. Those chemicals that can be identified by Chemical Abstracts Registry numbers were reviewed for both aquatic and mammalian toxicity using the one readily available source of information, the Registry of Toxic Effects of Chemical Substances published and updated quarterly by the U.S. National Institute of Occupational Safety and Health. Where toxicity information was available that indicated a chemical that should be of concern (based on carcinogenicity, teratogenicity, acute aquatic and mammalian toxicity, The Threshold Limit Value, and average annual use greater than 100 lbs.) the chemical was identified as a "Tier 1" chemical. We then used chemical similarity arguments to add other chemicals used in the State to the Tier 1 list. These Tier 1 chemicals form the basis for developing priority lists for specific programs. For example, we have been able to compile a list of chemicals by basin that are on the Tier 1 list, used in large amounts, and analyzable by readily available standard procedures. This list will be used to guide our monitoring program. These chemical priority lists are now being developed and will eventually serve to direct all our toxics programs at least from the scientific direction.

There is, in addition, a site priority process (P2) that we have developed and are applying to the source trackdown program. Without some prioritization scheme we could be spending our resources tracking down problems that are relatively minor to the exclusion of major problems. Again we are attempting to place our decision-making on a more rational basis so that our resources are used more effectively and so that our decision-making process is more closely understood by all concerned.

STRATEGY PROBLEM AREAS AND CONSTRAINTS

There are a number of problems or constraints which hinder the working of any toxics control strategy. Some of these constraints reflect limited resources, some reflect gaps in our knowledge about toxic chemicals and their environmental

movement, and some reflect the problems inherent in making government work.

Basic to many of our problems is the absence of clearly defined risk estimates and the lack of general agreement on what amount of risk is acceptable to the public (or publics). If such estimates were available our actions and reactions would be more predictable and stable and hence easier for industry and municipalities to live with. We need much more information than we have now on both mammalian and aquatic toxicity of chemicals. We need to know much more than we do now about the risks and hazards associated with the presence of certain chemicals at certain levels in particular parts of the environment.

On the other side of the ledger we need to know the true costs associated with controlling a chemical substance. These costs include regulatory costs, costs for treatment, and indirect costs connected with either decreased use of certain chemicals or costs associated with treatment and control. In general, when you solve a problem you create at least one other problem. The full cost of solving a problem should also take into account the losses associated with the other problems that are created.

Then there is need for a balancing act to weigh the risks against the costs to make some decision for action. This is particularly difficult because the risks and costs associated with toxic chemicals and their control do not fall on the same person, or even group of persons. This is a type of distributive problem where trade-offs among groups is needed. It is this class of problems that we developed our present complex political processes to solve.

But even if we know what we should be doing and the resources are available to do it do we have any way of interrogating the environment to find out how effective our abatement procedures are? To my knowledge we have no generally agreed upon way of determining whether the environment is improving or getting worse with respect to toxic chemicals. The best we are able to do now is look for long-term trends in concentrations of specific chemicals at specific places. Indeed, New York itself has done quite a bit of this with respect to certain man-made chemicals in fish flesh in major waterways throughout the State. But should our effectiveness criteria be based solely on chemical-by-chemical analyses or are there other schemes that would allow us to assess more realistically whether or not our control strategies are really working?

One resource which poses a tight constraint on monitoring and implementation of control and remedial programs is the laboratory service resource. Chemical analysis on environmental samples at the ppb or ppm level is extremely difficult and requires both sound procedures and capable chemists--both of which are in short supply. In New York we are trying to put more money into this aspect of our program but we are not yet sure that money is the limiting constraint--at least in the short run. We are also exploring the application to practical environmental situations of a number of screening tests that would allow us to

closely define the problem area before the more expensive chemical analysis procedures are brought into use.

Effective management of toxics problems requires close coordination among a number of scientific disciplines, among a number of agencies, and a number of diverse groups within agencies. Resources for toxics control compete with resources for other purposes and there is even competition among different parts of the toxics control program. Coordination of the disciplines and agencies involved is probably the single most important element of the strategy. Yet, we all know that such coordination is difficult under ideal circumstances and at times impossible.

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The Analysis of Dioxins in Environmental Samples

by

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INTRODUCTION

There now exists a high level of public concern over the potential risk to health from dioxins. Any suggestion that dioxins could be present in products, foodstuffs or the environment is followed up by intense media coverage and demands by the public for action. Although various routes have been discovered by which dioxins can enter the environment, the one which has received the most publicity is the use of the contaminated herbicide, 2,4,5-trichlorophenoxy acetic acid (2,4,5-T).

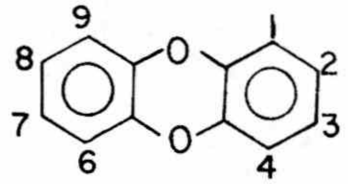
It's important that the overall hazard to public health from dioxins be put in proper perspective. Although one member of this family, namely 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8 TCDD) has been labelled the deadliest of all man-made poisons, exposure of the populace in general to this contaminant is probably extremely limited.

This paper contains background information on dioxins in general, an outline of their toxic properties, both acute and long term, and general information on the sources and environmental fate of dioxins. Also discussed are the laboratory procedures for handling such toxic materials, analytical methodology to separate "dioxin" from the matrix in question, and some of the programmes the Ontario Ministry of the Environment is currently involved in for measuring residue levels of dioxin.

When the public or media hear that "dioxins" have been discovered in some product, or in the environment, there is an unfortunate tendency for them to immediately jump to the conclusion that what is present is 2,3,7,8-TCDD. This is but one of 75 chlorinated dioxins.

Figure 1 illustrates the basic dioxin molecule. This structure of two aromatic or benzene rings linked by 2 oxygen atoms is known as dibenzo-p-dioxin. The chlorinated dioxin family is derived from this basic molecule by addition of anywhere from 1 to 8 chlorine atoms to this structure. The positions on this molecule are numbered as shown in this figure and indicate positions at which chlorine atoms (or others) can be substituted for hydrogen atoms in the basic structure.

Figure 1. Structure of dibenzo-p-dioxin



Addition of 4 chlorine atoms gives tetrachlorodioxin. There are 22 possible arrangements or in other words, different positional TCDD isomers.

The various possible arrangements of chlorine atoms yield 75 different possible chlorinated dioxins. These are tabulated in Table 1.

Table 1

Chlorodibenzo-p-dioxin Isomers

No. of Chlorines	Isomer Name	No. of Isomers
1	Monochloro	2
2	Dichloro	10
3	Trichloro	14
4	Tetrachloro	22
5	Pentachloro	14
6	Hexachloro	10
7	Heptachloro	2
8	Octachloro	1
TOTAL		75

The fact that there are different possible arrangements of chlorines would have little significance except for the fact that every different arrangement of chlorine atoms imparts a different set of physical, chemical and most importantly, toxicological properties to the basic molecule. For example, the toxicity of 2,3,7,8-TCDD is 10,000 times greater than that of the 1,2,3,4 isomer.

The 2,3,7,8 tetrachloro configuration turns out to be one of the most toxic chemicals known to man. It is 2,3,7,8-TCDD whose toxic properties are frequently, but incorrectly assumed to reflect the properties of all the chlorodioxin family.

2,3,7,8-TCDD is a white crystalline solid with a melting point of 300°C. It will thermally decompose at temperatures of 700-800°C. It is inert to most chemicals. Exposure to light (ultraviolet) results in decomposition of 2,3,7,8-TCDD to phenolics.

TOXICITY (ACUTE AND CHRONIC)

Most of the detailed toxicity studies available have concentrated on the effects of 2,3,7,8-TCDD because of its unusual level of activity. Thus, much of the comparative data presented are for this compound.

Table 2 shows the acute toxicity of 2,3,7,8-TCDD in comparison with a number of more familiar poisons in order of increasing minimal lethal dose.

Table 2
Toxicities of Selected Poisons

Substance	Minimal Lethal Dose (g/kg)
Botulinum toxin A	3.0×10^{-11}
Tetanus toxin	1.0×10^{-10}
Diphtheria toxin	3.0×10^{-7}
2,3,7,8-TCDD	1.0×10^{-6}
Curare	5.0×10^{-4}
Strychnine	5.0×10^{-4}
Sodium cyanide	1.0×10^{-2}

In acute toxicity studies, 2,3,7,8-TCDD is highly toxic. The minimal lethal dose for rodents (mice, rats, guinea pigs) for 2,3,7,8-TCDD is 10,000 times lower than for cyanide, and 500 times lower than strychnine.

All this data is derived from acute toxicity studies. Except in the case of industrial/occupational accidents, or accidental consumption of a contaminated product, the general public will never be exposed to this type of dose, and thus acute toxic effects will seldom pose a risk to most people. What is possibly of more cause for concern is the potential for long-term low level exposure to dioxin due to environmental contamination.

Long term animal exposure studies using 2,3,7,8-TCDD show changes in cell structure, alteration in the cell's genetic coding and enzyme induction changes.

The type of effects which have originated from chronic exposure of test animals are as follows:

1. Chloracne, blistering, porphyria and melanosis
2. Degenerative liver changes
3. Teratogenic effects causing birth defects in test animals
4. Fetotoxic effects (still-birth or abortion of fetuses were observed at levels as low as 50 ppt in diet of rhesus monkeys)
5. Carcinogenic and co-carcinogenic effects to rats at levels as low as 5 ppt in diet.

Although most of this data is derived from animal tests, epidemiological studies of human exposure to 2,3,7,8-TCDD due to accidents have shown up many similar symptoms.

The most publicized cases of acute and/or chronic exposure to 2,3,7,8-TCDD have been:

1. "Agent Orange" herbicide used in Vietnam
2. Sevaso "Hexachlorophene explosion"

There is an ongoing controversy over interpretation of what has happened as a result of these incidents. Many of the obvious physical symptoms of dioxin poisoning showed up in Sevaso victims. These were similar to what was described for animal tests, namely: chloracne, porphyria, central nervous system disorders, internal organ disorder and melanosis.

In addition to these episodes, there have been more than 200 occupationally related cases of dioxins. These have mainly been due to industrial accidents in plants using chlorophenols.

These data are for 2,3,7,8-TCDD exposure as this is still of major concern. However, other members of the dioxin family also have similar toxic effects, but at a much lower level than 2,3,7,8-TCDD.

Octachlorodioxin for example, is 50,000 times less toxic than 2,3,7,8-TCDD and other dioxins have toxicities intermediate between these extremes. Toxic action appears to be related to structure. It appears that for significant toxicity, at least 3 of the 4 positions 2,3,7 or 8 must contain chlorine, and the molecule must still contain at least 1 hydrogen atom. The limited data available on effects of long term action of other dioxins also appears to correlate well with these criteria. The chronic toxicity appears to be related to an individual dioxins ability to enhance or induce the activity of specific enzymes in the cell.

Examples of these large variations in effects of different dioxins should demonstrate why it is so important to identify and specify exactly which dioxin is present in a given sample in order to make a realistic assessment of risk potential, and to ensure dissemination of accurate public information.

ORIGINS OF DIOXINS

Except for scientific research purposes, no one intentionally manufactures dioxins, nor do they occur naturally. Dioxins occur exclusively as accidental or unwanted by-products of chemical reactions designed to make other products. Dioxins can also be formed and discharged during the incineration of municipal & chemical wastes, depending on the type of waste feed and operating conditions.

The basic chemicals from which dioxins are formed are chlorophenols. When a chlorophenol is reacted at elevated temperatures (160°C) in the presence of a base like sodium hydroxide, dioxins are formed by reaction of 2 chlorophenol molecules. Any chlorophenol with a chlorine atom adjacent to the phenolic group can undergo this reaction.

In the commercial manufacture of the herbicide 2,4,5-T, 1,2,4,5-tetrachlorobenzene is reacted with sodium hydroxide in methanol producing the 2,4,5-trichloro sodium phenoxylate. This in turn is reacted with the sodium salt of chloroacetic acid to produce 2,4,5-T. When temperatures of greater than 160°C are reached the phenoxylate will react with itself producing first a phenoxylate phenyl ether (a pre-dioxin) and then undergoing the same reaction of having the phenoxylate displace a chlorine that is adjacent to the phenol (or phenol-ether bond). Thus, 2,3,7,8-TCDD can be produced as a by-product of 2,4,5-T manufacture.

The Dow Chemical Co. has put forward their "Trace Chemistry of Fires" theory which states that most combustion sources produce dioxins. This has generated considerable controversy. Acceptance of this theory would mean that chemical manufacturers and users could no longer be singled out as the main sources of dioxins in the environment, and would imply that we have been living with dioxins ever since fire was discovered.

Dow has reported the presence of a wide range of dioxins from many different combustion sources, as well as in urban and household dust. They have detected dioxins in chemical waste incinerators, municipal incinerators, cigarette smoke, automobile mufflers, ashes from barbecue pits, even barbecued steaks.

European researchers have obtained similar results from municipal and industrial incinerators, with regard to fly ash from these units. The results presented in Table 3 are for dioxin levels from European incinerators.

Table 3

Chlorodioxins in Incinerator Fly Ash

	Fly Ash (ppb)*	Stack Particulates (ppb)
Tetra-CDD	5-110	100
Penta-CDD	31-488	800
Hexa-CDD	80-1200	1370
Hepta-CDD	190-902	1370
Octa-CDD	266-1100	310

* Range of 80 analyses

Dioxins detected in these plants (non-chemical incinerators) were primarily the higher chlorinated dioxin species, namely octa-, hepta-, hexa- and penta-, with lower levels of tetra-'s and very little 2,3,7,8-TCDD. Reports from U.S. investigators indicate that levels of 15 mg/hour of total TCDD were emitted from a municipal incinerator. These researchers have investigated the effects on dioxin levels of the chemical makeup of the material being incinerated and, using

laboratory pyrolysis of test compounds, have been able to model the processes. This has resulted in the proposal of a series of precursors and chemical reactions which can produce dioxin from the incineration of municipal garbage.

The previously stated reaction mechanism of chlorophenols to form dioxins is again crucial. Chemicals such as chlorobenzenes and PCB were shown to form dioxins during incineration. For example a PCB transformer fire in Binghamton, N.Y., in February of this year produced 2,3,7,8-TCDD as the major TCDD isomer in ppm concentrations in the soot. The building has remained closed. Compounds like vinyl chloride, which can be liberated by the burning plastics, were shown to form chlorobenzenes, and in turn dioxins. Current work shows that many organics, when heated with a source of chlorine can undergo this reaction. There is even an indication that simple carbon sources such as coal, when heated with salt could form dioxins. I should point out that the flyash and flue gases from coal-fired thermal generating plants have been investigated. Preliminary studies indicate that no dioxins have been found.

DIOXIN ENVIRONMENTAL BEHAVIOUR

Once dioxins enter the environment their behaviour can be predicted from the following:

1. Dioxins tend to be strongly associated with particulates in air and water phases. They are strongly adsorbed to airborne dust and/or soil.

2. Dioxins do not easily leach from the soil column.

3. Dioxins are extremely resistant to bacterial and chemical degradation. Their half-life in lake water sediment is approximately 500 days.

4. Dioxins are prone to photodegradation in solution and vapour phase. Particulate bound dioxins are not easily photolysed.

5. Dioxins are bioaccumulatable, and do magnify up the food chain. High levels of 2,3,7,8-TCDD have been detected in fish from Vietnam (up to 1 ppb) and from various wildlife samples from Sevaso-Italy, up to 49 ppb. Experimental fish have been shown to accumulate 7,000 times the level in spiked water.

DIOXIN LABORATORY FACILITIES

In establishing facilities in which the chlorinated dioxins and other similarly toxic pollutants can be analysed, two points must be considered: first, one has to establish a set of safety standards to protect the analysts; and secondly, one must develop methodology which is sensitive enough to pick up very low, part per trillion (ppt) levels of dioxins from a very analytically complex matrix, such as a fish. There are two major prerequisites:

1. The laboratory area must be isolated from other areas of analysis for the safety of analysts not involved with the analysis of these toxic compounds, and also, to avoid contamination of the chlorinated dioxin samples with other chlorinated compounds.

2. The air into the laboratory must be clean and free of particulate matter - again to avoid contamination of the samples. The air out of the fumehoods and venting from the instruments into the atmosphere, must also be clean. This is accomplished by having a carbon and particulate filter in the venting system.

Stringent laboratory practices are needed with a high hazard laboratory. The laboratory is always kept "medically locked" (doors have a locking system without a master key). Laboratory personnel are required at all times to wear backtie surgical lab coats, disposable surgical gloves and safety glasses. This clothing is not worn outside the lab. Standards are kept in a locked freezer, accessible only to authorized personnel. Only working level standards (ng/mL) are present in the work area. Concentrated extracts are stored in a locked freezer in 0.1 mL vials.

Sample extracts or dilute standards are transported in sealed vials in a shipping container, and placed in a sealed plastic container and marked "Danger - Hazardous Chemical". These are transported only by senior lab personnel. Cleaning staff clean only the floors at designated times when no hazardous chemicals are in use. Solid waste is sealed in plastic bags and disposed of by incineration. Solvents are distilled, tested for dioxin residues, and then disposed of in the normal fashion.

At the Ontario Ministry of the Environment laboratory, a yearly medical surveillance program was initiated for all personnel working in the hazardous lab. It consists of the following:

- a general examination
- a chest x-ray
- an electrocardiogram
- complete urinalysis and blood serum analysis

As blood serum analysis is the most satisfactory way of determining early symptoms of disease, extensive testing is done every three months and includes the following:

1) A sequential multiple analysis where functions of the liver, kidney, bone and lipid can be monitored.
2) Other blood tests such as blood sugar, blood count, etc.

PROGRAMMES

The Ministry has three major programmes for dioxin determination. The first is the analysis of raw and treated drinking water for total tetrachlorodioxins. The majority of the samples are from the Niagara Area. Various sites are sampled on a monthly basis.

The second programme is the analysis of 2,3,7,8-TCDD in the edible portion of sports fish. The majority of fish analysed have been from Lake Ontario, but fish from all of the Canadian Great Lakes have been analyzed. Approximately 15 different species have been tested.

The third programme is the analysis of dioxins associated with municipal incineration. This is a joint project between the Ministries of Energy and Environment. The project calls for the quantitation of 2,3,7,8-TCDD as well as total tetrachlorodioxins. In addition, total penta, hexa, hepta and octachlorodioxins will be quantitated.

Analyses for dioxins in ambient air, soils and sediments, leachates and solid and liquid wastes will be available in the near future.

ANALYSIS

Analytical techniques which uniquely identify and measure specific dioxins at low ppt levels have only recently been developed and validated. Of all of the matrices, the analysis of 2,3,7,8-TCDD in fish tissue is one of the most demanding for the analyst. There are three basic steps in the analysis: extraction, cleanup and identification or confirmation.

The sample of ground fish fillet is first treated with hydrochloric acid, which breaks down the fish tissue, and is then extracted with an organic solvent, hexane.

The cleanup is as follows: the hexane extract is passed through two sulphuric acid columns and an alumina column to remove the bulk of the sample matrix and some of the chemical interferences. The sample can now contain organic contaminants such as PCB that are up to 1,000,000 times more concentrated than any dioxin. Additional columns such as silver nitrate and alumina remove greater than 99% of these interferences. A final high pressure liquid chromatographic step is required for complete removal of interferences, and to allow for isomer specific determination of the 2,3,7,8-TCDD.

The identification of 2,3,7,8-TCDD is carried out primarily on a gas chromatograph/mass spectrometer (GC/MS). A capillary GC column usually 30 metres in length is used. The criteria for identification are: 1) retention time must be the same as that of the standard by GC and GC/MS; 2) the ions produced by mass spectrometry must have the same ions as the standard, and in the same ratios. The overall recovery of an isotope labelled internal standard ^{13}C 2,3,7,8-TCDD must be greater than 65%. The detection limit for fish is 10 ppt.

The analysis of dioxins in fly ash presents a completely different set of problems. There are copious amounts of dioxins to work with, as compared to those in fish analysis, but there are a tremendous number of dioxin isomers present. The only TCDD isomer detected in fish by all of the laboratories doing this analysis is 2,3,7,8-TCDD. In fly ash, over 14 of the 22 positional tetrachloro isomers have been reported in the fly ash extracts. This abundance of isomers is also found in the penta and hexa dioxins. The problem now becomes one of identification of specific isomers. For this one needs to have standards of the isomers that are to

be identified, and these are not readily available. For example, only four tetra isomers are commercially available. Exceptional HPLC and capillary gas chromatography are also needed to be able to separate the various isomers.

Fly ash is acidified, then soxhlet extracted with toluene for 48 hours. These cleanup steps are very similar to those used for fish cleanup. The GC/MS criteria for identification also remain the same. Chlorine labelled ^{37}Cl octachlorodibenzodioxin is used as an internal standard. Water samples are extracted with pentane, the extract is concentrated, and then analyzed directly by GC/MS.

STATUS OF TCDD IN FISH

At this time a round robin quality check is being carried out in 14 laboratories (4 of them Canadian) with identical samples of Lake Ontario fish, to verify TCDD fish data. This information is critical for valid health hazard assessment.

Health risk assessment will be obtained from Health and Welfare Canada and the Provincial Ministry of Labour, in consultation with U.S. officials.

When the Ministry has this information there will be a meeting with U.S. authorities to agree upon the useable fish data, and the assessment of health risks, if any. Appropriate action will be taken and the data will be released.

As yet no dioxins have been detected in water or drinking water supplies in Ontario (detection limit 1.0 ppt). The only positive values for waterborne TCDD (total) in the Great Lakes area have been obtained in dumpsite leachates at the Love Canal/Hyde Park area in Niagara Falls, where levels of 1-5 ppb were detected. This work was done by N.Y. State.

SUMMARY

Because of the large variation in effects of the various dioxins, it is important to specify exactly which dioxin is present in a given sample. The Ministry currently has three major programmes for the determination of dioxins. The types of matrices in which dioxins will be analyzed will be expanded in the near future to meet the increasing needs of the Ministry.

Ontario Liquid Waste Carriers Association

by

Alec Thomas, Chairman OLWCA

My purpose this morning is to describe briefly the history, objectives and activities of the newly formed Ontario Liquid Waste Carriers Association. Everyone in this room, I'm sure, is aware that the nature of the Liquid Waste Carriage Industry has changed dramatically in the last decade. Most industrial waste carriers, although not all of us, started out as septic tank pumpers. Many of our companies are small operations, and some like mine, for example, are family owned.

My company was founded by my father in 1959, as a septic tank maintenance company. Ten years later Thomas Waste Removal Limited entered the industrial waste management field and since then my company's business has changed rapidly and significantly. The changes have been caused by two forces:

First: development in industry requirements, and second: the ever increasing role played by government in regulating the management of waste.

The impact of the creation of the Ministry of the Environment in the early seventies was major. It co-incided with the growing general recognition that waste, particularly industrial waste, was something that could not simply be thrown away and forgotten about, but was rather something that required careful and intelligent management.

Politicians, industry, academics, and the public at large finally started to realize that the by-products of our industrial society could no longer be dealt with haphazardly. At the same time, the Federal Government was already well launched on what has turned out to be a decade long exercise to regulate dangerous goods transportation. Municipal governments also began to express more concern about waste management, particularly transportation within their boundaries.

As this was happening, we found that the demands of our customers began to change as well. We were asked to deal with a wider range of products and to adapt to new and changing technologies. In response to these demands waste carriers found themselves consulting with chemists, engineers, and each other, much more frequently.

In 1974, a group of liquid waste carriers met in Kitchener to voice various concerns and to explore the possibility of establishing an organization. Following a series of meetings, it was clear that our common interests were sufficiently significant and wide-ranging to merit a

formal Association. Since many of us at that time were members of the Ontario Trucking Association already, it seemed natural to look to OTA as our sponsoring group. Participants in the Kitchener meeting joined the OTA Tank Truck Carriers Division and established within it a Liquid Waste Carriers Committee.

We found this arrangement satisfactory for several years, but in the last two or three years as our industry took on a higher public profile, and not necessarily a positive public profile, we came to recognize that it was important to establish our own organization.

The first step in establishing our Association was to identify and contact all of the Liquid Waste Carriers in the province. Without the co-operation of the Ministry of the Environment the task would have been far more difficult than it was. Subsequently we had series of regional meetings to advise carriers of our plans. On September 16, 1980 we had our innaugural meeting, elected a Board of Directors, and our new Association was born. So much for the history; what are our objectives?

Very simply, we want the government to regulate us properly, we want to establish high standards of performance for our industry, and we want to continue the process of developing our professional expertise.

Our Association, like other trade and professional Associations will act in a variety of ways on behalf of our membership. In addition to writing a model regulation which we will ask the Government of Ontario to enact for our industry (about which our General Counsel, Bob Warren, will say more) we are also well advanced in the process of developing standards for our equipment. As a result of the co-operation of the companies that manufacture vacuum tank vehicles the Association has been able to bring together a working group of technical experts which will write the necessary safety standards. We have established contact with the Canadian Standards Association which is developing the Federal Dangerous Goods Code Standard for highway and portable tanks.

C.S.A. has assured us that a standard developed by our Association which is acceptable to their technical experts will be included in their report to the Dangerous Goods Secretariat. As you know, the Federal Dangerous Goods Code will establish specifications for hazardous material vehicles by referencing standards developed by the C.S.A. As you also know, Ontario has already introduced

legislation which will adopt the federal code, and as a result we are confident that our proposal will become law in Ontario.

Implementation of the C.S.A. standard combined with Ontario's enactment of our proposed regulation will make the liquid waste carriage industry in this province one of the most stringently regulated sectors from the point of view of safety. May I remind you, this will be regulation that our industry has written and requested the government to implement. We feel that it will effectively rid our industry of a small element of irresponsible operators and will ensure that anyone licensed to transport industrial liquid waste demonstrates competence and proper regard for public safety and the environment.

As an Association, we are moving rapidly to assume the responsibilities that all industrial sectors should accept in the public interest. We are struggling to raise the level of public and official understanding of our industry and the crucial service it provides and the problems that it faces.

In this vain we have agreed to meet with representatives of the residents of South Cayuga to provide them with basic information about liquid waste transportation which will help them participate more meaningfully in the upcoming hearings. We have agreed to meet with the research director of the health study being conducted on the upper Ottawa street landfill site, in order to assist in identifying materials that went into that facility. We are participating in a number of truck route studies being conducted by various regional municipalities. We have contacted George McKie of the Moe Special Investigation Unit and will meet with him to discuss ways in which our Association can assist the Unit. We plan to mount a press education program which may help to deal with the vast ignorance which exists in the media about industrial waste transportation. This, we hope, will make some contribution to countering the "not in my backyard" syndrome which has complicated all of our problems.

Because we recognize the necessity of a treatment facility of last resort we are not in disagreement with the concept of the Ontario Waste Management Corporation. We will be participating in the hearings on the corporation site proposal.

We have invited the corporation Vice Chairman, Harvey Polk, to participate in a meeting of the Association

membership on July 22nd in the hope of initiating a dialogue and assisting the corporation to understand liquid waste transportation. At the same time we will be making the point that the corporation facility should be managed in such a fashion as to augment rather than supercede private disposal facilities.

Finally, we are engaged in conversation with the Ministry of Environment to develop appropriate driver training programs for our operators.

In short, we are working very hard to be constructive, responsible participants in the waste management process in Ontario.

Thank you.

* * * * *

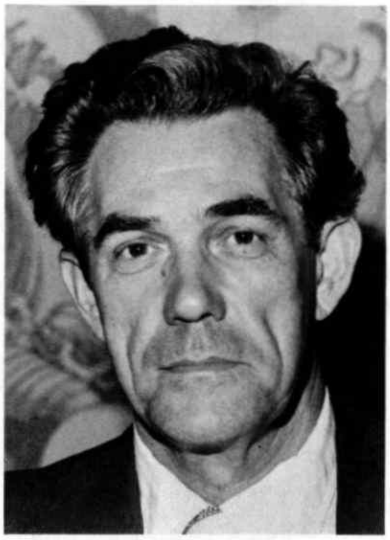
Note: A second paper was also delivered at this session by R.B. Warren, General Counsel to the Ontario Liquid Waste Carriers Association, but no text was received from the author for incorporation in the Proceedings.

Regulation of the Industrial
Liquid Waste Carriage Industry
by
R. B. Warren, General Counsel
to the Ontario Liquid Waste
Carriers Association

Paper given in conjunction with
A.F. Thomas, Chairman, OLWCA,
presentation.

Note: The text of Mr. Warren's paper was not made available by the author for inclusion in these Proceedings.

SESSION IV – LIQUID INDUSTRIAL WASTES



Chairman: D. Hoskins,
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T. Fowle, President,
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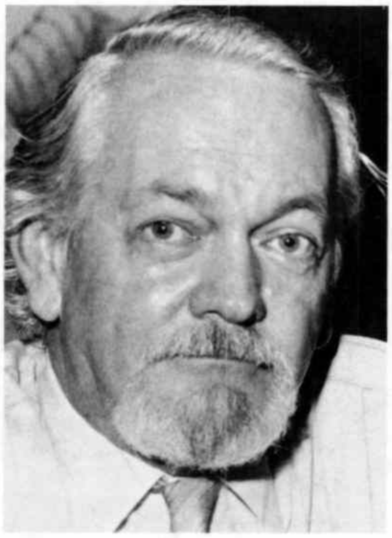

Dr. Donald A. Chant, Chairman,
Ontario Waste Management Corporation,
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G. W. Scott, Q.C.
Deputy Minister
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INDUSTRIAL WASTE DISPOSAL
MYTH & REALITY

by
T. Fowle
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THIS TIME LAST YEAR THREE INDUSTRIAL WASTE DISPOSAL PROJECTS WERE PROPOSED FOR ONTARIO. ALL OF THEM WERE PROMISING AND BADLY NEEDED. TWO WERE TO ESTABLISH SOLIDIFICATION PLANTS, WHICH WERE CO-SPONSORED BY THE MINISTRY OF THE ENVIRONMENT AND TWO PRIVATE COMPANIES. THE OTHER WAS THE PROPOSAL OF THE REGIONAL MUNICIPALITY OF DURHAM TO CONVERT ITS REDUNDANT SEWAGE TREATMENT PLANT IN AJAX INTO A PHYSICAL/CHEMICAL FACILITY TO TREAT CERTAIN TYPES OF WASTES.

BY THE END OF THE YEAR, EVERY ONE OF THESE THREE PROJECTS WAS IN SERIOUS TROUBLE. THE TWO SOLIDIFICATION PLANTS WERE TO HAVE BEEN THE SUBJECT OF HEARINGS UNDER THE ENVIRONMENTAL ASSESSMENT ACT, BUT FAILED TO PROCEED TO THE HEARING STAGE WHEN THE PROVINCIAL GOVERNMENT WITHDREW ITS SUPPORT. IN AJAX, WE WENT THROUGH A PUBLIC HEARING LASTING SIX MONTHS UNDER THE ENVIRONMENTAL PROTECTION ACT, AND EVEN AFTER RECEIVING A FAVOURABLE REPORT FROM THE ENVIRONMENTAL ASSESSMENT BOARD, THE REGIONAL MUNICIPALITY, IN THE FACE OF FIERCE PUBLIC OPPOSITION, DECIDED NOT TO PROCEED WITH CONSTRUCTION OF THE FACILITY.

THE REPORTS OF LOCAL REACTION TO PROPOSALS IN THE PROVINCES OF QUEBEC AND ALBERTA, AND IN UPPER NEW YORK STATE TOLD US THAT OTHER PROJECTS WERE COMING UNDER MUCH THE SAME KIND OF FIRE AS OURS HAD.

THESE EVENTS AND OUR EXPERIENCE AT THE AJAX HEARING HAS PROMPTED THIS PAPER. IT IS UNFORTUNATE AND SAD THAT THERE IS A WIDESPREAD MISUNDERSTANDING ABOUT INDUSTRIAL WASTE TREATMENT FACILITIES AND THAT ERRONEOUS PERCEPTIONS ABOUND.
IT WAS FELT THAT AN INFORMED RESPONSE TO THESE BELIEFS IS NEEDED.

WHAT ARE INDUSTRIAL WASTES?

THERE IS A WIDELY-HELD BELIEF THAT LIQUID INDUSTRIAL WASTES ARE EXOTIC CONCOCTIONS WHICH ARE DANGEROUS TO HEALTH AND WHICH WILL REQUIRE THE MOST ADVANCED AND SOPHISTICATED TECHNOLOGY TO TREAT. IN THE MINDS OF MANY, THERE IS NO CONNECTION BETWEEN WASTE STREAMS AND THE RAW MATERIALS AND PROCESSES FROM WHICH THOSE WASTES HAVE ORIGINATED.

IN FACT, THE RAW MATERIALS, FOR EXAMPLE AN ACID BATH, ARE MUCH MORE REACTIVE AND POTENTIALLY HAZARDOUS THAN AN ACID WASTE STREAM SINCE THE RAW MATERIAL ONLY BECOMES A WASTE AFTER ITS REACTIVITY HAS BEEN SPENT.

IT IS INTERESTING TO LOOK AT A FEW EXAMPLES OF INDUSTRIES AND THEIR WASTES TO FURTHER ILLUSTRATE THIS POINT.

AN ELECTRIC LAMP MANUFACTURER - PRODUCING NITRIC, AND SULPHURIC ACID WASTES.

A STEEL FABRICATOR - PRODUCING A MIXTURE OF OIL AND WATER.

A TYPESETTING COMPANY - WITH WASTE PHOTOGRAPHIC CHEMICALS.

A PAINT MANUFACTURER - WITH WASTE ORGANIC SOLVENTS.

HOW MANY PEOPLE WOULD CONNECT THE MANUFACTURE OF ELECTRIC LIGHT BULBS WITH THE USE OF SULPHURIC ACID OR THE PRODUCTION OF ACID WASTES. YET WE ARE SURROUNDED BY SUCH ACTIVITIES AND PROCESSES PRODUCING WASTES OF THIS TYPE ARE COMMONPLACE.

THE GAP OF PERCEPTION

THIS BRINGS ME NOW TO ANOTHER MAJOR DIFFICULTY, NAMELY, THE GAP OF PERCEPTION THAT EXISTS BETWEEN LOCAL RESIDENTS AND THOSE WHO ARE PROPONENTS.

THERE CAN BE NO DOUBT THAT THE PUBLIC LOOK UPON INDUSTRIAL WASTE TREATMENT PLANTS AS HIDEOUS MONSTERS THAT WILL POSE A SERIOUS THREAT TO THE HEALTH AND WELL BEING OF THEIR COMMUNITY; AND WHERE HIGHLY COMPLEX AND DANGEROUS ACTIVITIES TAKE PLACE.

THESE PLANTS ARE PERCEIVED AS HAVING THE POTENTIAL FOR DISCHARGING NOXIOUS FUMES, SPILLING DEADLY CHEMICALS INTO RIVERS AND LAKES, AND HAVING THE CAPACITY TO EXPLODE AT THE SLIGHTEST MALFUNCTION.

INDUSTRIAL WASTE DISPOSAL HAS BECOME A FAVOURITE TOPIC OF NEWS DOCUMENTARY PROGRAMMES AND THESE PROGRAMMES USUALLY SINGLE OUT THE WORST EXAMPLES OF THE WASTE INDUSTRY, AND DRAMATIZE ANY DOUBTFUL CONDUCT.

THE AJAX FACILITY WAS THE SUBJECT OF TWO SUCH PROGRAMMES, ONE WHILE THE HEARING ITSELF WAS IN PROGRESS. BOTH OF THESE PROGRAMMES BROUGHT ATTENTION TO THE PROJECT, BUT DEALT WITH

ONLY A FEW OF THE ISSUES AND BECAUSE OF THE LIMITED TIME AVAILABLE, IN ONLY A CURSORY WAY.

HOW THEN IS A PROJECT PERCEIVED BY THE PROPONENT?

FIRST OF ALL, AS ALREADY MENTIONED, THE PLANT WOULD DEAL WITH LIQUIDS THAT HAVE ALREADY BEEN USED IN INDUSTRIAL PROCESSES AND THEIR REACTIVITY WOULD HAVE BEEN SPENT.

THE PROCESSES PROPOSED FOR THE AJAX PLANT WERE ALL STANDARD CHEMICAL PROCESSES, WHICH ARE COMMONLY EMPLOYED BY THE INDUSTRIAL COMMUNITY AT LARGE.

AN INDUSTRY TREATING ITS OWN WASTE STREAM COULD VERY WELL BE USING THE SAME PROCESSES IN ANY TYPICAL INDUSTRIAL NEIGHBOURHOOD, WHICH OFTEN ARE LOCATED WITHIN A STREET'S WIDTH OF PEOPLE'S HOMES.

THE TANKS AND ALL OF THE VARIOUS ITEMS OF EQUIPMENT THAT WOULD BE USED TO BUILD THE FACILITY WOULD ALL BE SELECTED FOR THE MATERIALS TO BE HANDLED JUST LIKE ANY OTHER MUNICIPAL FACILITY OR INDUSTRIAL PLANT.

IN ITS SIMPLEST TERMS, THEREFORE, THE FACILITY WOULD BE A CHEMICAL PLANT LIKE MANY SUCH PLANTS, WHICH CAN BE FOUND IN MANY OF OUR ESTABLISHED COMMUNITIES.

THE ONLY AREAS IN WHICH THE FACILITY WOULD DIFFER FROM MANY INDUSTRIAL PLANTS WOULD BE IN RELATION TO CONTROLS THAT WOULD BE PLACED ON WASTES THAT WOULD BE ALLOWED TO BE BROUGHT TO THE PLANT, CONTROL OF SPILLS, PROCESS CONTROLS, AND THE QUALITY CONTROL OF THE EFFLUENT THAT WOULD BE DISCHARGED FROM THE PLANT INTO THE SANITARY SEWER SYSTEM.

THE CHECKS AND CONTROLS THAT WOULD BE CONSTANTLY IN EFFECT, WOULD BE FAR MORE STRINGENT THAN REQUIRED OF INDUSTRY IN GENERAL.

SO, IN THE MINDS OF THE PUBLIC THEY ARE BEING ASKED TO ACCEPT IN THEIR COMMUNITY A FEARFUL MONSTER WHICH NOBODY ELSE WANTS, AND TO THE PROPONENTS THE FACILITY WILL REPRESENT AN IMPORTANT ENVIRONMENTAL ASSET WHICH, COMPARED WITH MANY INDUSTRIAL ESTABLISHMENTS, SHOULD RECEIVE A HIGH SCORE.

OBVIOUSLY, SOMETHING MUST BE DONE TO BRIDGE THE GULF THAT EXISTS BETWEEN THE PERCEPTION BY CITIZENS OF INDUSTRIAL WASTE TREATMENT AND THE SIMPLE TRUTH OF REALITY.

HEALTH AND SAFETY PERCEPTIONS

MANY ASSERTIONS ARE MADE ABOUT WASTE PLANTS BEING A SOURCE OF DANGER AND POTENTIALLY DAMAGING TO THE HEALTH OF THOSE IN WHOSE COMMUNITY THE PROJECT IS TO BE ESTABLISHED.

IN FACT, IN AJAX THE MEDICAL STAFF OF THE LOCAL HOSPITAL WENT SO FAR AS TO PASS A RESOLUTION OPPOSING THE PROJECT AS PROPOSED ON THE GROUND THAT IT DID NOT CONTAIN ADEQUATE HEALTH PROTECTION TO THE CITIZENS OF THE SURROUNDING REGION.

IN RESPONSE, A LETTER WAS WRITTEN TO THE HOSPITAL ADMINISTRATOR POINTING OUT THAT THE PLANT WOULD BE A PUBLIC HEALTH FACILITY SINCE IT WOULD PROVIDE FOR THE TREATMENT OF WASTES, AND THE DOCTORS WERE ASKED TO BE SPECIFIC ABOUT THEIR CONCERNS. ALSO THEY WERE INVITED TO JOIN THE PROJECT TEAM AND MAKE ANY CONTRIBUTION TO THE PROJECT THAT MIGHT BE APPROPRIATE TO ADDRESS THEIR CONCERNS.

NO RESPONSE WAS RECEIVED FROM THE MEDICAL STAFF, AND NOT ONE OF THEM CAME TO THE HEARING TO GIVE EVIDENCE. UNFORTUNATELY, HOWEVER, MUCH PUBLICITY WAS GIVEN TO THEIR ORIGINAL RESOLUTION AND IT DID A GREAT DEAL OF HARM TO THE CREDIBILITY OF THE PROJECT.

ALTHOUGH THERE IS GENERAL AGREEMENT AS TO THE NEED FOR THESE FACILITIES, NONE OF THE COMMUNITIES WHERE THEY WERE TO HAVE BEEN LOCATED HAS IDENTIFIED ANY DIRECT BENEFIT FROM THE FACILITY.

EVEN IF A PROPONENT WERE TO OFFER ATTRACTIVE INCENTIVES TO PROVIDE A TANGIBLE DIRECT BENEFIT, THE MOOD OF THE PUBLIC IS SUCH THAT ANY ACTION OF THIS KIND WOULD BE INTERPRETED AS PROOF THAT THE FACILITY IS BAD FOR THE COMMUNITY AND ACCORDINGLY NO AMOUNT OF COMPENSATION WOULD BE ACCEPTABLE.

A COMPARISON BETWEEN THE DRUGS AND OTHER CHEMICAL COMPOUNDS USED IN HOSPITALS FOR TREATMENT AND FOR TESTING PURPOSES, AND THE TYPES OF CHEMICALS WHICH COMPRISE TYPICAL INDUSTRIAL WASTES, MAKES FOR INTERESTING READING IF ONE IS TO EVALUATE THESE RESPECTIVE MATERIALS ON THE BASIS OF THE POTENTIAL EFFECTS TO OUR BODIES.

MOREOVER, THE AIR AND LIQUID BORNE DISCHARGES FROM HOSPITALS OFTEN CONTAIN PATHOGENS WHICH ARE VIRULENT TO MAN.

BECAUSE FACILITIES SUCH AS HOSPITALS HAVE NOT RECEIVED THE ATTENTION AND PUBLICITY ACCORDED WASTE TREATMENT PLANTS, THE PUBLIC HAS NO REASON TO QUESTION WHAT TAKES PLACE WITHIN THEIR WALLS. NOR HAS THERE BEEN ANY PUBLIC CONCERN ABOUT THE DISPOSAL OF HOSPITAL WASTES. QUITE RIGHTLY, HOSPITALS ARE REGARDED AS VITAL AND HIGHLY DESIRABLE PUBLIC HEALTH FACILITIES.

OBVIOUSLY THE ISSUE IN THIS EXAMPLE BOILS DOWN TO PERCEPTION. HOWEVER, EVEN IF HOSPITALS WERE TO BE SUBJECTED TO THE PUBLIC HEARING PROCESS THEY WOULD STILL RECEIVE PUBLIC ACCEPTANCE FAR MORE READILY THAN A WASTE TREATMENT PLANT. THIS IS BECAUSE THE INDIVIDUAL CITIZEN INVOLVED WILL RECOGNIZE AND VALUE THE DIRECT PERSONAL BENEFITS THAT A HOSPITAL WILL PROVIDE. ACCORDINGLY, ANY ACCOMPANYING HAZARDS ARE LIKELY TO BE ACCEPTED.

THIS EXAMPLE BRINGS INTO SHARP FOCUS ONE OF THE MOST IMPORTANT REASONS WHY WASTE TREATMENT PLANTS HAVE BEEN BITTERLY CONTESTED.

SLIDE PRESENTATION

THE NEXT PART OF MY PRESENTATION WILL COMPRISE A SERIES OF COLOUR SLIDES ILLUSTRATING THE LOCATION AND LAYOUT OF THE AJAX FACILITY AS PROPOSED, AND SHOWING ALSO SOME TYPICAL CHEMICAL-RELATED INDUSTRIES IN THE INDUSTRIAL PART OF AJAX AND IN ANOTHER INDUSTRIAL AREA A FEW MILES AWAY IN METROPOLITAN TORONTO.

I WILL ENDEAVOUR TO SHOW THE EXTRAORDINARY LENGTHS THAT WOULD BE TAKEN FOR THE AJAX FACILITY WITH REGARD TO THE CONTROL OVER INCOMING WASTES, THE STORAGE OF WASTES, CONTAINMENT OF SPILLS, AND SITE DRAINAGE WATER WHICH COULD BE CONTAMINATED FROM MINOR ROAD SPILLS.

ALTHOUGH TIME DOES NOT PERMIT A DISCUSSION OF THE PROCESSES PROPOSED, ALL WASTES WOULD FINALLY PASS THROUGH SAND AND THEN CARBON ADSORPTION FILTERS.

PRIOR TO DISCHARGE TO THE MUNICIPAL SEWERAGE SYSTEM THE TREATED EFFLUENT WOULD HAVE BEEN STORED TO PERMIT EXTENSIVE TESTING AS A FINAL SAFEGUARD. THESE MEASURES WENT FAR BEYOND THOSE REQUIRED UNDER ANY STATUTES OR BYLAWS OR EMPLOYED BY INDUSTRY IN GENERAL.

THE CHEMICALS STORED AT THE INDUSTRIES SHOWN IN THE FOLLOWING SLIDES INCLUDE, METHYL ACRYLATE, KELTHANE, TOLUENE, FORMALDEHYDE, NAPHTHA, METHANOL, NITRIC AND HYDROCHLORIC ACID, SODIUM HYDROXIDE AND SODIUM BICHROMATE.

THESE COMPOUNDS ARE VARIOUSLY RATED AS HIGHLY TOXIC, HIGHLY FLAMMABLE, AND DANGEROUS. LOW CONCENTRATIONS OF MOST OF THEM WILL DAMAGE VITAL ORGANS. ALL OF THEM WOULD NORMALLY REQUIRE SPECIAL MEASURES FOR HANDLING, STORAGE AND TRANSPORTATION.

<u>SLIDE SEQUENCE</u>

1. ZONING MAP

   INDUSTRIAL AND RESIDENTIAL AREAS, GREENBELT

   TRUCK ROUTE

   COLOURED AREA, APPROX. 4 MILES E-W

2. BIRD'S EYE VIEW OF MODEL

3. RECEIVING AREA - INDUSTRY NO. 1

   RAIL CARS - TOLUENE

   TANK TRUCKS

   SIGN ON FENCE - NO OPEN LIGHTS

4. SIGN ON TANK CAR

   TOLUENE - FLASH POINT 40°F

5. VIEW OF STORAGE TANKS

   NO SPILL CONTROL

   HIGHLY FLAMMABLE CHEMICALS

   HOUSES 1,000 FEET AWAY

6. DISCHARGE TO STORM DRAIN

   SPILLS OR LEAKS TO STORM DRAIN AND NEARBY CREEK

7. STORAGE TANK AND STORM DRAIN

   HOUSES IN BACKGROUND

8. STORAGE TANKS - INDUSTRY NO. 2

   NITRIC & HYDROCHLORIC ACIDS, SODIUM HYDROXIDE & BICHROMATE

   NO SPILL OR LEAKAGE CONTROL

   TREATMENT LAGOON IN FOREGROUND

9. TREATMENT LAGOON - INDUSTRY NO. 2

10. TANK FARM - INDUSTRY NO. 3

    SOLVENT & OIL STORAGE

    IRREGULAR LOW EARTH BERM

    DRUM STORAGE

11. TANK FARM - INDUSTRY NO. 3

    TANK SUPPORTS

    PIPE THROUGH FENCE

12. ENTRANCE - INDUSTRY NO. 4

    SIGN - NO SMOKING

    - NO MATCHES

    - NO OPEN LIGHTS

    DRUM STORAGE

13. VIEW OF STORAGE TANKS - INDUSTRY NO. 4

    METHANOL

    NAPHTHA

14. STORAGE TANKS - INDUSTRY NO. 5

    BERM OF CRUSHED STONE

15. STORAGE - INDUSTRY NO. 5

    NO FENCES

    NO SPILL CONTROL

    HIGHLY FLAMMABLE AND TOXIC

16. HOUSE NEAR PLANT - INDUSTRY NO. 6

17. TREATMENT LAGOON - INDUSTRY NO. 6

    NEUTRALIZATION PROCESS OF A LOW PH WASTE

    IDENTICAL TO ONE OF PROCESSES PROPOSED FOR AJAX

    PLASTIC LINER

    HOUSES IN BACKGROUND LESS THAN 300 FT. AWAY

18. STORAGE TANKS

METHYL ACRYLATE

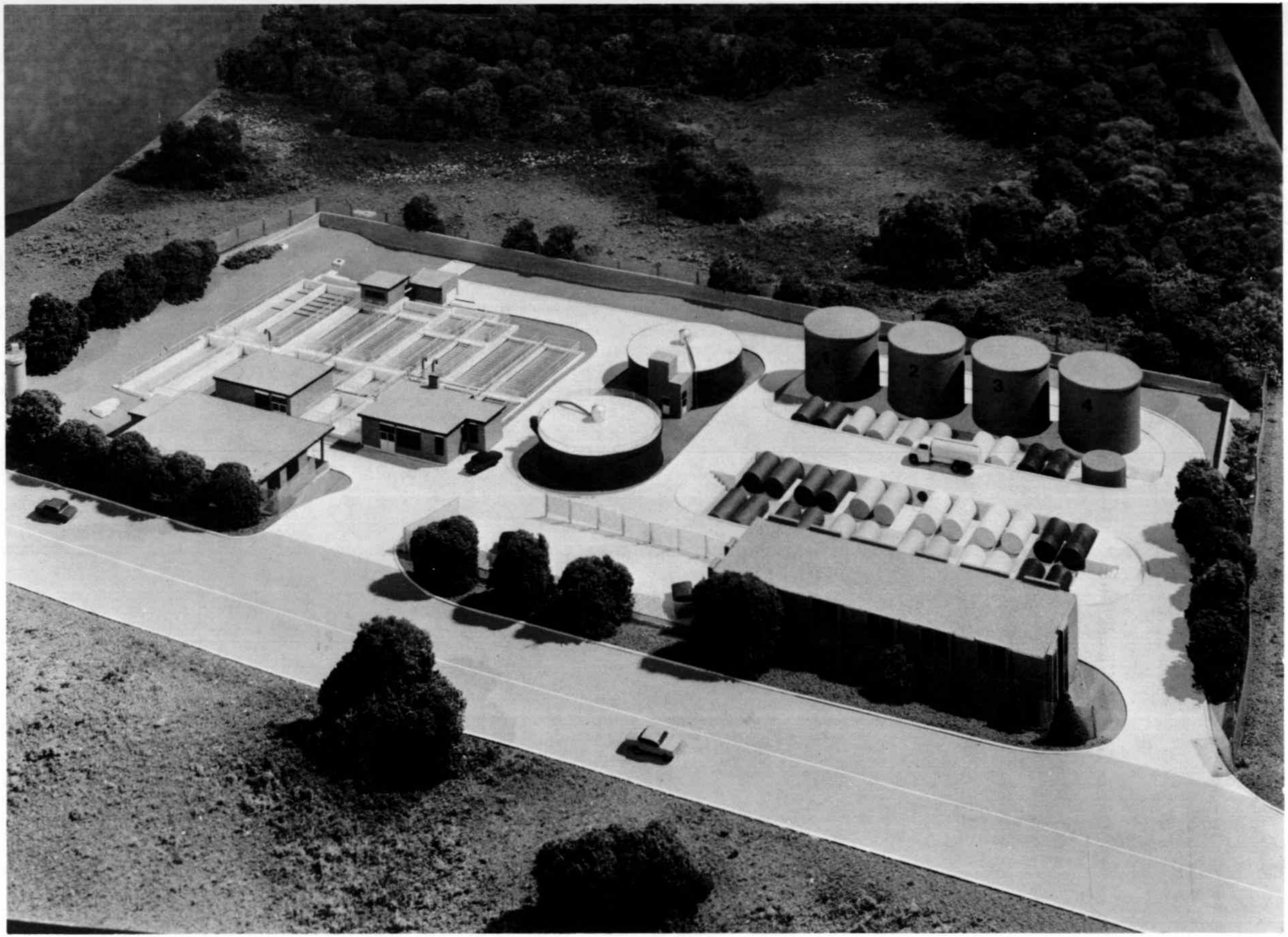
CRUSHED STONE BERM

19. 45 GAL. DRUMS KELTHANE - INDUSTRY NO. 6

HIGHLY TOXIC MITICIDE

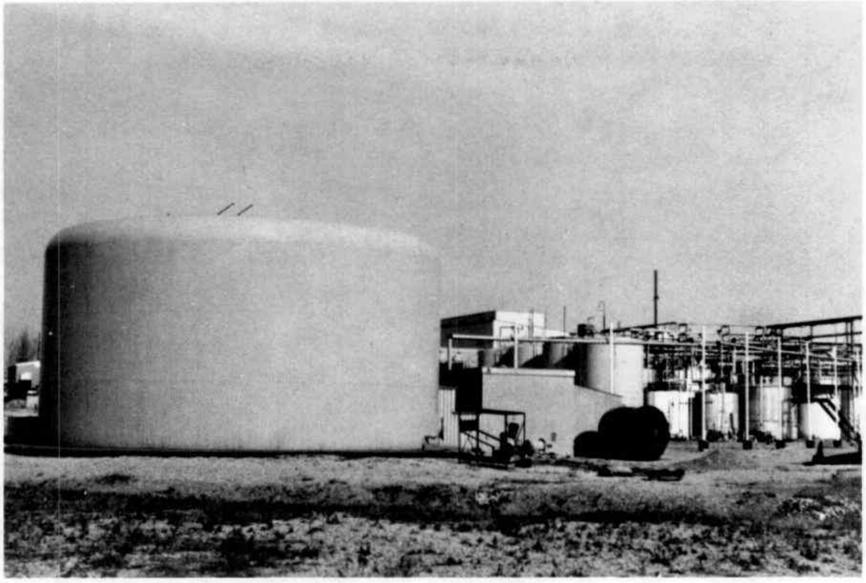
VERY SIMILAR TO D.D.T. A SUSPECTED CARCINOGEN

DANGEROUS



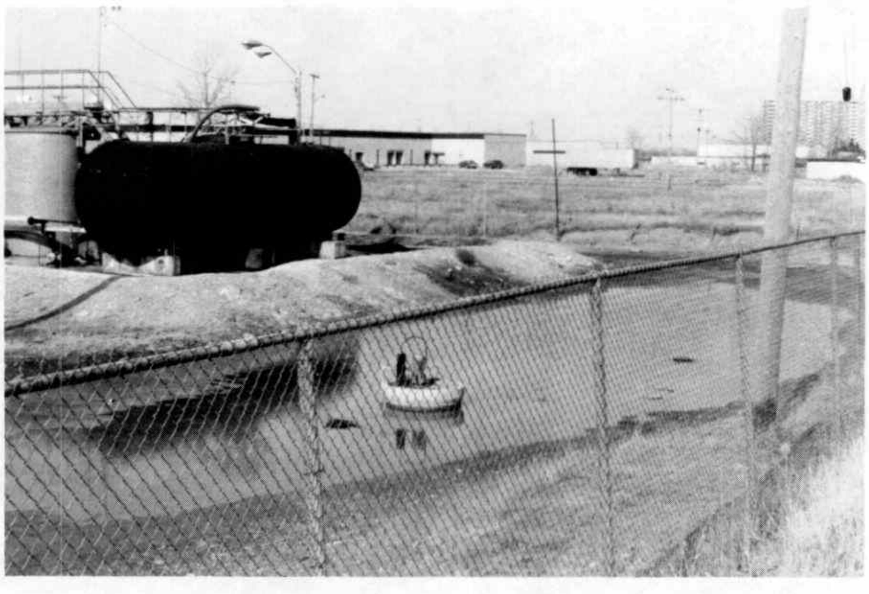
SLIDE NO. 1

Model of industrial waste treatment plant proposed for Ajax.



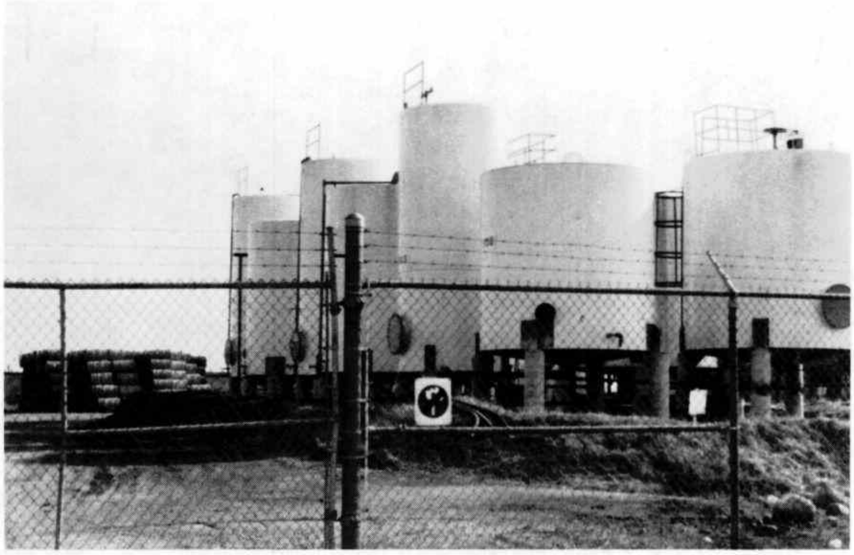
SLIDE NO. 5

View of storage tanks.



SLIDE NO. 8

Storage tanks for nitric and hydrochloric acids, and sodium hydroxide and bichromate. Treatment lagoon in foreground.



SLIDE NO. 10

Tank farm for oils and solvents storage.

SLIDE NO. 12

Tank farm for storage of methanol and naptha.

INDUSTRIAL DEVELOPMENT

ONE OF THE MAJOR OBJECTIONS MADE BY THE OPPONENTS TO THE AJAX FACILITY, WAS THAT IT WOULD ATTRACT INDUSTRIES THAT WOULD BE WASTE PRODUCERS. ALSO THAT INDUSTRIES USING CHEMICALS AS RAW MATERIALS WOULD BE INTERESTED IN LOCATING IN AJAX AND CONSEQUENTLY, MORE CHEMICALS WOULD BE BROUGHT INTO THE COMMUNITY TO SERVICE ANY SUCH INDUSTRIES.

THERE IS LITTLE QUESTION THAT THERE IS CERTAIN VALIDITY TO THESE ARGUMENTS, ALTHOUGH MOST OF THE INDUSTRIALLY-ZONED LAND IN AJAX IS ALREADY OCCUPIED AND AS INDICATED EARLIER, A WIDE VARIETY OF INDUSTRIES ARE PRODUCERS OF INDUSTRIAL WASTES.

SINCE THIS QUESTION WAS RAISED, IT IS WORTH EXAMINING THE EFFORTS MADE BY MUNICIPALITIES TO ATTRACT INDUSTRY AND THE CONTROL WHICH IS EXERCISED OVER THE TYPES OF INDUSTRIES WHICH ARE ALLOWED TO ESTABLISH IN A TYPICAL INDUSTRIAL NEIGHBOURHOOD.

ACCORDING TO THE INDUSTRIAL DEVELOPMENT ASSOCIATION OF CANADA, THERE ARE APPROXIMATELY 250 MUNICIPALITIES WHO EMPLOY AN INDUSTRIAL DEVELOPMENT COMMISSIONER AND WHO IN SOME INSTANCES, IS SUPPORTED BY A LARGE STAFF AND A SUBSTANTIAL BUDGET. THE MAIN FUNCTION OF THESE PEOPLE IS TO ATTRACT INDUSTRY INTO THE COMMUNITY WHICH THEY SERVE.

SINCE FOR MOST MUNICIPALITIES INDUSTRIAL DEVELOPMENT IS REGARDED AS THE LIFE BLOOD OF THE COMMUNITY, BOTH AS EMPLOYERS AND AS TAXPAYERS, THERE ARE VERY FEW MUNICIPALITIES WHO WILL NOT TREAT

A PROSPECTIVE INDUSTRY LIKE ROYALTY AND COMPETE VIGOROUSLY WITH OTHER POSSIBLE LOCATIONS IN AN EFFORT TO CAPTURE THE INDUSTRY FOR THEIR MUNICIPALITY.

BUT HOW MANY MUNICIPALITIES ASK THE PROSPECTIVE INDUSTRY WHETHER THEY ARE PRODUCERS OF LIQUID WASTES, WHETHER THEY WILL BE BRINGING CHEMICALS INTO THE COMMUNITY, HOW THESE CHEMICALS MIGHT BE STORED AND WHAT POTENTIAL HAZARDS TO THE COMMUNITY MIGHT BE EXPECTED? SINCE MOST ZONING BYLAWS IMPOSE NO CONDITIONS OR RESTRAINTS IN THIS RESPECT, THESE QUESTIONS ARE HARDLY LIKELY TO ARISE.

LET US NOW COMPARE THE RECEPTION LIKELY TO BE ACCORDED A COMPANY WHICH WISHES TO ESTABLISH A LIQUID WASTE TREATMENT FACILITY. BASED ON RECENT EXPERIENCE, IT IS ALMOST CERTAIN THAT IT WILL BE INDICATED TO THEM THAT THEY WOULD NOT BE WELCOME, AND THEY WOULD PROBABLY BE POLITELY TOLD TO TRY THEIR PROPOSAL ELSEWHERE.

ON THE BASIS OF A LOGICAL ANALYSIS, THE WASTE TREATMENT PLANT MIGHT WELL BE A HIGHLY DESIRABLE INDUSTRY FOR THE COMMUNITY. UNFORTUNATELY, HOWEVER, THE RESPONSE TO THE PROPOSAL IS MORE LIKELY TO BE BASED ON A FALSE PERCEPTION AND CONCERN FOR PUBLIC REACTION.

LET US LOOK NOW AT HOW A
PROPOSAL CAN BE MISREPRESENTED

AT A HIGHLY EMOTIONAL PUBLIC MEETING ARRANGED BY AJAX CITIZENS TOGETHER (ACT), THE CITIZENS' GROUP OPPOSING THE PROJECT, THEIR LAWYER IN HIS ADDRESS MADE A NUMBER OF ASSERTIONS INCLUDING THE FOLLOWING:

> "THEY ARE GOING TO MIX CHEMICALS TOGETHER AND SPEW THEM INTO THE AIR AND WATER - YOUR DRINKING WATER. THEY'LL TRANSFER THE WASTE FROM WHERE IT IS GENERATED TO YOUR BODIES."

AS THIS SPEAKER WAS INTRODUCED AS AN ENVIRONMENTAL LAWYER, IT IS APPROPRIATE TO ANALYZE THIS STATEMENT.

IT WOULD BE FAIR TO SAY THAT IT CONTAINS A PARTICLE OF TRUTH.

SO LET US EXAMINE THE FACTS TO WHICH THE STATEMENT PRESUMABLY REFERRED.

THE TREATED EFFLUENT FROM THE PROPOSED PLANT WOULD, LIKE OTHER INDUSTRIAL EFFLUENTS, SATISFY THE MUNICIPAL SEWER USE BYLAW. IT WOULD, THEREFORE, CONTAIN LOW CONCENTRATIONS OF A NUMBER OF METALS, SUCH AS CHROMIUM, COPPER, IRON, ETC.

AFTER EXTENSIVE TESTING, THIS EFFLUENT WOULD BE DISCHARGED INTO AN ADJACENT MUNICIPAL SEWER, WHICH IN TURN WOULD CARRY THE EFFLUENT TO A NEW AND VERY LARGE MUNICIPAL SEWAGE TREATMENT PLANT IN NEARBY PICKERING.

JUST LIKE THE OTHER INDUSTRIAL DISCHARGES ENTERING THIS PLANT, SOME TREATMENT WILL TAKE PLACE AND METALS CONCENTRATIONS AND BOD, ETC., WILL ALL BE REDUCED.

RESIDUAL CONCENTRATIONS WILL ALWAYS BE PRESENT, HOWEVER, SINCE COMPLETE ELIMINATION IS IMPOSSIBLE.

THE EFFLUENT FROM THIS SEWAGE TREATMENT PLANT, WILL BE DISCHARGED INTO LAKE ONTARIO BY WAY OF AN OUTFALL WITH A SPECIALLY DESIGNED DIFFUSER ABOUT 3,000 FEET FROM SHORE.

AT THIS STAGE, WE BELIEVED WE WERE KNOCKING ON THE DOOR OF PERFECTION.

THE NEARBY WATER SYSTEMS FOR BOTH AJAX AND PICKERING, TAKE WATER FROM LAKE ONTARIO AND TREAT IT IN MODERN PLANTS FOR CONSUMPTION IN BOTH COMMUNITIES. THE NEAREST WATER INTAKE IS 1 KM AWAY FROM THE SEWAGE OUTFALL.

IN AN ABSOLUTE SENSE, IT IS STATISTICALLY CERTAIN, THAT AT SOME TIME MOLECULES OF THE RESIDUAL ELEMENTS DISCHARGED FROM THE INDUSTRIAL WASTE TREATMENT PLANT, WOULD ENTER THE INTAKES FOR THE WATER PLANTS SERVING AJAX AND PICKERING AND THAT IN DUE COURSE, MOLECULES OF THOSE ELEMENTS WOULD ENTER THE BODIES OF CONSUMERS. THAT IS THE PARTICLE OF TRUTH.

DESPITE THE FACT THAT WE HAD DEMONSTRATED THAT THE AJAX WATER SUPPLY WOULD NOT BE AFFECTED BY THE WASTE PLANT AND THE TREATMENT PLANT WOULD CONTINUE TO PRODUCE HIGH QUALITY WATER, ACT'S LAWYER MADE NO MENTION OF THESE FACTS IN HIS SPEECH.

SO WHILE, AS I SAID, A PARTICLE OF TRUTH COULD BE FOUND IN HIS ASSERTION, THIS STATEMENT WAS A MOUNTAIN OF DISTORTION.

SUCH DISTORTIONS PLANTED THE SEEDS OF FEAR, MISTRUST AND DISBELIEF IN THE MINDS OF THE PUBLIC.

THESE FEELINGS THEN PERSISTED DESPITE THE EFFORTS THAT HAD BEEN MADE OVER A PERIOD OF TWO YEARS, TO BRING THE PROJECT TO THE ATTENTION OF THE PUBLIC AND MAKE INFORMATION AVAILABLE.

THE FEAR AND MISTRUST CREATED BY EXAGGERATED AND GROSSLY MISLEADING STATEMENTS AT HIGHLY CHARGED PUBLIC MEETINGS, CAUSED DAMAGE THAT WAS IRREPARABLE.

AS THIS DAMAGE WAS DONE BEFORE ANY EVIDENCE WAS PRESENTED AT THE HEARING, IT CAME AS NO SURPRISE THAT IN THE TWO NIGHT SESSIONS WHEN THE PUBLIC AT LARGE COULD MAKE REPRESENTATIONS TO THE BOARD, THEY SAID THEY WERE CONFUSED, FRIGHTENED AND ENTRENCHED OPPONENTS OF THE PROJECT.

EXAMPLES OF DOMESTIC HAZARDS AND POLLUTION SOURCES

A FEW SIMPLE EXAMPLES WILL ILLUSTRATE HOW WE ARE ALL EXPOSED TO A VARIETY OF HAZARDS IN OUR EVERYDAY LIVES AND HOW AS A SOCIETY WE ARE POLLUTING OUR ENVIRONMENT ON A VASTLY GREATER SCALE THAN COULD POSSIBLY ARISE FROM A WASTE TREATMENT FACILITY.

IT IS NOW ESTIMATED THAT THERE ARE MORE THAN 400,000 CANADIAN HOMES THAT POSSESS A MICROWAVE OVEN AND THIS NUMBER IS EXPECTED TO REACH ONE MILLION WITHIN A FEW YEARS. RESEARCH HAS INDICATED THAT THE POTENTIAL HAZARDS TO WHICH USERS CAN BE EXPOSED FROM RADIATION LEAKAGE CAN BE BOTH PHYSIOLOGICAL AND BEHAVIOURAL. ALTHOUGH RIGID CONTROLS ARE IN EFFECT FOR NEW PRODUCTS, ONCE ONE OF THESE APPLIANCES HAS BEEN MANUFACTURED THERE ARE NO FURTHER CONTROLS TO CHECK WHETHER IT IS SAFE FOR CONTINUED OPERATION. IT IS INTERESTING THAT A CLOCK MANUFACTURER HAS RECENTLY BROUGHT A SIMPLE DO-IT-YOURSELF TESTING DEVICE ON TO THE MARKET. THIS COMPANY PLACED A LARGE ADVERTISEMENT IN A MAJOR NEWSPAPER PROMINENTLY SHOWING THE SOURCES OF RADIATION LEAKAGE. SUCH POTENTIAL HAZARDS MAKE ONE WONDER HOW THE MICROWAVE OVEN WOULD STAND UP TO THE SCRUTINY OF THE PUBLIC HEARING PROCESS.

RECORDS SHOW THAT IN THE GREAT LAKES DRAINAGE BASIN OF ONTARIO ALONE, APPROXIMATELY 4,500,000 LBS. OF *ACTIVE* INGREDIENTS OF HERBICIDES AND PESTICIDES ARE USED EACH YEAR. BY THEIR VERY NATURE THESE ARE HIGHLY TOXIC SUBSTANCES, SPECIFICALLY DESIGNED TO INTERFERE WITH NATURAL BIOCHEMICAL STRUCTURES. A COMMONLY-USED PESTICIDE WHICH I HAVE AT HOME BEARS THE FOLLOWING WARNING

ON THE LABEL: "THIS PRODUCT IS TOXIC TO FISH AND WILDLIFE. KEEP OUT OF LAKES, PONDS AND STREAMS". YET HOW MANY OF US DO NOT USE 2,4-D TO KILL DANDELIONS OR MELATHION TO KILL APHIDS? BUT HOW MANY OF US STOP TO CONSIDER THE ULTIMATE DESTINY OF THESE CHEMICALS WHICH INEVITABLY LEAD TO OUR STREAMS AND GROUNDWATER? WE ARE, IN FACT, ADDING THESE CHEMICALS TO OUR OWN NATURAL WATERS.

THESE AND COUNTLESS OTHER SIMILAR EVENTS ARE OCCURRING DAILY WITH BARELY A MURMUR OF DISSENT.

1980 CONFERENCE

AT THIS CONFERENCE LAST YEAR, A PAPER WAS READ ON BEHALF OF DAVID ESTRIN ENTITLED, "SITING HAZARDOUS WASTE DISPOSAL FACILITIES - HOW TO PREVENT LAWSUITS AND THE NOT IN MY BACKYARD SYNDROME".

IN THAT PAPER MR. ESTRIN COMMENTED ON THE ENDEAVOURS OF THE MINISTRY OF THE ENVIRONMENT AND THE VARIOUS WASTE TREATMENT FACILITIES THAT HAD RECENTLY BEEN PROPOSED.

WITH REGARD TO THE AJAX PROPOSAL IN PART HE STATED:

> "THE PROPOSAL AS PRESENTED TO THE ENVIRONMENTAL ASSESSMENT BOARD WAS EMPTY OF DETAIL:
>
> - WHILE THE PROPOSAL SUBMITTED BY SIMCOE ENGINEERING ON BEHALF OF THE REGION WAS BULKY, APPROXIMATELY HALF OF IT CONSISTED OF NEWSPAPER CLIPPINGS.

WHEN ONE LOOKED TO SEE THE TECHNICAL BASIS FOR THE PROPOSAL, ONE FOUND SOME CONSIDERABLE THEORETICAL, FIRST YEAR UNIVERSITY CHEMISTRY TEXT BOOK STYLE DISCUSSION OF THE PRINCIPLES OF NEUTRALIZATION AND PRECIPITATION, BUT NO SERIOUS ATTEMPT MADE TO RELATE THE THEORIES TO THE ACTUAL FACILITY. VERY LITTLE WAS FOUND IN THE PROPOSAL WITH REGARD TO WHAT PROCESSES WOULD BE CARRIED ON WHERE AND HOW."

THE FACTS ARE AS FOLLOWS:

AT THE COMMENCEMENT OF THE HEARING, WE FILED A SCALE MODEL AND FIVE VOLUMES OF BOUND DOCUMENTS, ONE OF WHICH WAS DEVOTED EXCLUSIVELY TO A TECHNICAL DESCRIPTION OF THE PROPOSED TREATMENT.

THIS VOLUME INCLUDED A FLOWCHART OF THE PROPOSED PROCESSES, AND THE TEST RESULTS FROM BENCH-SCALE TREATMENT WORK COMPLETED ON TWENTY-FIVE DIFFERENT INDUSTRIAL WASTES USING THE SAME PROCESSES AS PROPOSED FOR THE FACILITY.

ALMOST 1,000 ANALYTICAL RESULTS FROM THIS WORK WERE PRESENTED TO DEMONSTRATE THE EFFECTIVENESS OF THE PROPOSED TREATMENT.

IN MANY CASES THESE RESULTS SHOWED CONTAMINANT REDUCTIONS GREATER THAN 99.9%. THIS LABORATORY WORK WAS CARRIED OUT ON SAMPLES OF ACTUAL INDUSTRIAL WASTES REPRESENTING THE FULL SPECTRUM OF THOSE PROPOSED TO BE TREATED. THESE SAMPLES WERE COLLECTED FROM INDUSTRIES IN THE REGION OF DURHAM AND SURROUNDING AREA.

DURING THE COURSE OF THE HEARING WE FILED ADDITIONAL MATERIAL WHICH, IN ALL, MADE UP A TOTAL OF 77 EXHIBITS, INCLUDING A PROPOSED PLANT LAYOUT CLEARLY IDENTIFYING WHERE TREATMENT PROCESSES WOULD OCCUR.

TESTIMONY WAS GIVEN BY TWO EXPERIENCED CHEMICAL ENGINEERS, WHICH FOR THE PROCESSES AND CONTROLS ALONE, OCCUPIED A PERIOD OF MORE THAN TEN DAYS, WHICH IS REPORTED IN THE SAME NUMBER OF VOLUMES OF TRANSCRIPT. THIS EVIDENCE WAS EXHAUSTIVE AND FREQUENTLY DETAILED.

WITH REGARD TO NEWSPAPER CLIPPINGS, NOT HALF OF THE PROPOSAL BUT ALMOST HALF OF ONE VOLUME DID INDEED COMPRISE COPIES OF NEWSPAPER REPORTS. THIS WAS DONE IN AN EFFORT TO DEMONSTRATE THE EFFORTS MADE BY THE REGION OF DURHAM TO BRING THE PROJECT TO THE ATTENTION OF THE PUBLIC FOR ALMOST TWO YEARS PRIOR TO THE HEARING.

THE BOUND DOCUMENTS AND MODEL ARE ON VIEW AND I INVITE YOU TO JUDGE FOR YOURSELVES THE DEPTH AND QUALITY OF THE PROPONENT'S CASE.

CONCLUSIONS

AND NOW FOR SOME CONCLUSIONS.

TO THOSE IN THE WASTE TREATMENT FIELD IT IS EVIDENT THAT MOST LIQUID INDUSTRIAL WASTES ARE NOT EXOTIC, HIGHLY DANGEROUS MATERIALS, BUT RATHER THEY ARE THE WASTE PRODUCTS OF MANUFACTURERS AND PROCESSING PLANTS WHICH CAN BE FOUND IN VIRTUALLY ANY INDUSTRIAL NEIGHBOURHOOD.

NEXT, INDUSTRIAL WASTE PLANTS INSTEAD OF BEING LOOKED UPON AS HAVING A SPECIAL CHARACTER AND REQUIRING UNIQUE SITE SELECTION CRITERIA, SHOULD BE TREATED LIKE ANY OTHER INDUSTRY EMPLOYING ESTABLISHED CHEMICAL PROCESSES WHICH ARE PART OF EVERYDAY LIFE IN AN INDUSTRIALIZED SOCIETY. TO ARGUE OTHERWISE IMPLIES THAT THE BASIC RULES OF PLANNING ARE FUNDAMENTALLY WRONG AND SHOULD BE CHANGED.

IF THESE BASIC PREMISES CAN BE ACCEPTED BY THE PUBLIC AT LARGE, SOME OF THE MOST SERIOUS MYTHS WHICH HAVE SHROUDED THE REAL ISSUES WILL HAVE BEEN STRIPPED AWAY. THIS WOULD PERMIT THE FUNDAMENTAL REALITIES OF INDUSTRIAL WASTE TREATMENT TO BE REVEALED.

REGRETABLY, HOWEVER, IN THE PRESENT CLIMATE WHAT COMMUNITY WILL WILLINGLY ASSENT TO THE ESTABLISHMENT OF A WASTE TREATMENT FACILITY IN ITS NEIGHBOURHOOD. MOREOVER, ATTITUDES ARE HARDENING AS SUCCESSIVE PROJECTS ARE STOPPED BY THE ACTIONS OF OPPOSING GROUPS.

URBAN DWELLERS ARE SAYING THESE PLANTS ARE UNSAFE AND SHOULD, THEREFORE, BE LOCATED AWAY FROM MAJOR POPULATION CENTRES, AND RURAL DWELLERS ARE SAYING THAT WASTES SHOULD BE TREATED IN THE TOWNS AND CITIES WHERE THEY ARE GENERATED.

ON THE ISSUE OF INDUSTRIAL WASTE DISPOSAL, OUR SOCIETY APPEARS TO HAVE LOST ITS SENSE OF DIRECTION, AND WE NOW NEED TO ESTABLISH THE GROUND RULES THAT WILL APPLY TO FUTURE PROJECTS.

A CONCERTED EFFORT IS NEEDED TO INFORM THE PUBLIC ABOUT THE OVERALL ENVIRONMENTAL PICTURE TO SHOW HOW WASTE TREATMENT IS IMPORTANT AND HOW IT WILL BENEFIT OUR ENVIRONMENT. WE NEED TO EXPLAIN THAT WASTE TREATMENT PLANTS ARE NOT ENVIRONMENTAL MONSTERS, BUT INDUSTRIAL FACILITIES LIKE MANY PLANTS WHICH PRODUCE THE CONSUMER GOODS THAT WE ENJOY.

AN EXPLANATION OF RISK IS NEEDED TO SHOW THAT IN THE COMPLEX URBAN ENVIRONMENT THAT WE HAVE CREATED WE ARE SURROUNDED BY POTENTIAL HAZARDS. MOST OF THESE RISKS POSE A FAR GREATER THREAT TO OUR HEALTH AND SAFETY THAN ANY THAT MIGHT ARISE FROM AN INDUSTRIAL WASTE TREATMENT PROJECT. THIS IS VERY DIFFICULT TO EXPLAIN AS PEOPLE SEEM TO BE FATALISTIC ABOUT EVENTS LIKE CAR ACCIDENTS, YET FEEL TERRORIZED BY INDUSTRIAL WASTES.

WE MUST EXPLAIN THE REALITIES OF THESE ISSUES TO POLITICIANS, ENVIRONMENTAL GROUPS AND MOST IMPORTANT OF ALL TO THE PUBLIC AT LARGE.

AND WE MUST DO SO IN THE LANGUAGE OF THOSE TO WHOM OUR MESSAGE IS ADDRESSED.

WE MUST SHOW UNDERSTANDING AND CONSIDERATION TO THOSE WHO ARE CONCERNED, AND WE MUST DISPLAY PATIENCE. BUT DAMAGING DISTORTIONS SHOULD NOT BE ALLOWED TO PASS UNCHALLENGED OR THEY WILL ACQUIRE CREDIBILITY.

AND FINALLY, IT IS OBVIOUS THAT WE FACE AN ENORMOUS CHALLENGE, BUT IT IS A CHALLENGE THAT MUST BE ACCEPTED BY THOSE WHO WORK IN THE WASTE TREATMENT FIELD.

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An Overview

of the

Ontario Waste Management Corporation

by

Dr. Donald A. Chant, Chairman

Note: Dr.Chant spoke from notes and personal observation. He did not have a formal text prepared which could be included in the Proceedings.

LIQUID INDUSTRIAL WASTE MANAGEMENT - THE MATURING PUBLIC ATTITUDE

by
L. Thibideau
Barrister & Solicitor
Cayuga, Ontario

I would first like to thank the Ministry of the Environment, and particularly Mr. Boyko for asking me to be with you this afternoon. I have been requested to direct my remarks to the Public Viewpoint on Industrial Liquid Waste Management. I suppose the first, and perhaps and obvious, comment I have is that there is really no "public viewpoint," but rather a variety of public attitudes and concerns many of which come to the fore when dealing with waste management and industrial liquid waste management in particular.

Generally industrial waste management has only come to wide public attention in the last decade or two. Certainly the amount of knowledge that the average person has of such matters has increased dramatically in the last 5 - 10 years. This is so for a variety of reasons including, use of chemicals on vast scales for defoliation in war, increased media coverage of scientific research into effects of chemicals on daily life, and of course, current publicity over acid rain, Love Canal type problems and the federal and provincial bans and restrictions on fishing and other activities because of pollution and contamination.

I think it is fair to say as well that the liquid waste treatment industry has also had a wider profile and expanding opportunities in the last decade or so. The trend away from dumping to treatment will hopefully create a bigger more sophisticated industry to the benefit of all of us.

I think it is also fair to say that when waste management began to gain general publicity through the media some major blunders like the Love Canal in the United States and other such problems resulted in suspicion and a lack of confidence in the handling of industrial wastes. But as the industry progresses public attitudes will as well and this is already happening. If I may I would like to cite three examples and then relate my comments to those. In the former County of Haldimand which lies between the Hamilton area and Lake Erie which also includes the industrial complex at Nanticoke where is situate major plants operated by Ontario Hydro, Texaco and Stelco we have had a succession of liquid waste disposal applications in the past 6 years or so. A brief look at 3 of them I hope will illustrate what I mean.

In 1976 a proposal was made to develop a site for injecting industrial liquid waste into existing deep gas wells for dispersal in underground rock formations. By the time public hearings commenced the applicant company with support from the Ministry of the Environment was ready with its proposal. But virtually no testing or site preparation was done prior to the hearings to determine site suitability or safety. All data to be used was simply a compilation of general information gathered from text books and studies unrelated to waste disposal such as the Canada Land Inventory, existing gas and oil well records and the like. Most of the criteria for a safe site now used appear to have been ignored and certainly were not tested for in the field. Public opposition at that time, some 6 years ago, was based more on what was not known or done by the applicant than anything else. The applicant terminated the proposal rather than risk the cost of site testing and development and what it considered would be lengthy public hearings.

Approximately 2 years later an alternative system of treatment lagoons and sludge fill sites were proposed by another applicant for the Nanticoke area in the former County of Haldimand. In this case some preliminary site testing was done and a good deal of designwork was completed before the application was made public and sent to hearings. All of this was closely monitored by the Ministry of the Environment with design changes made at the Ministry's suggestion from time to time. Unfortunately the project was suggested by a company with no real assets other than an option to buy the site and expertise borrowed almost totally from the Ministry and from an American company indirectly involved in the project.

As well, after several weeks of hearings it became clear that the site was not adequately tested to determine suitability and the application was denied by the Director of Approvals after full hearings before the Environmental Assessment Board.

Finally in my third example there is currently a proposal to concentrate most liquid industrial waste treatment and storage for Ontario at the former South Cayuga town site near Lake Erie adjacent to the Grand River and perhaps 10 miles from the Nanticoke area.

This last proposal is basically government sponsored and will be run by a Crown corporation in a way analogaus to the system used for dealing with other wastes - privately generated waste being processed and stored by government. I expect this trend will continue partly because of public concerns which I will detail shortly.

These 3 examples help illustrate some of the public concerns with waste treatment and also demonstrate how industry can move to solve the problems and lessenpublic hostility. They also though, show up continuing shortcomings.

I will not dwell on those fears which will be present no matter what action and precautions are taken. The "backyard syndrome" does exist to some extent with all industrial and non-compatible use activity. Nobody wants to live near a waste treatment site nor a steel mill, nor a rendering plant, nor even next door to a McDonald's because these interfere with normal residential and in some cases rural uses. But there are some valid concerns which can be met by prudent industry and government.

One of the causes of public hostility in the past has been the lack of confidence industry itself has demonstrated in its ability to manage industrial waste. In my first example the proponent was a company with some real assets, although the parent companies which appear to have owned the applicant proponent were much larger corporations. One couldn't help feeling that one reason for the subsidiary was to limit public liability and losses in the event of a serious problem. In the second example the proponent had paid up capital of $3.00 or $4.00 and an option to purchase a 100 acre parcel of agriculturally zoned land for the disposal site. Larger companies appeared to be behind the applicant company but of course, the applicant was an incorporated limited company and therefore the larger companies in the background would in no way be responsible for any losses incurred by the public. These arrangements which may be valid for other corporate reasons did little to engender public support and confidence in the projects proposed. Fortunately or unfortunately, depending on your philosophical point of view, this has lead to greater government involvement in the waste treatment industry. The result is that certain benefits have, or hopefully will, come from this.

There must be what I would term "eternal responsibility" for any major liquid industrial treatment waste facility. It is obvious that government will be with us for many, many years to come and will likely not cease operating or default on insurance or go bankrupt. The same cannot be said of private corporate entities especially when those entities have very little track record or virtually no real assets.

It is obvious as well that funding for research site testing and property acquisition on a large scale for treatment facilities are also required. It is becoming clear that for major treatment facilities the costs will inevitably be in the millions of dollar range and this financial load can only be borne by well funded private enterprise or government. As well, government involvement ensures a more orderly and systematic approach to such problems as road access, land use planning and land zoning, all of which are in the control of either senior local government or the provincial government.

The public has also become sufficiently aware of the problems to demand more countability from those engaged in industrial waste treatment and storage. The public while not very trusting of the government process these days still believe they can through the media and the political process influence decision on waste management if government is involved. The feeling is strong enough that even where private industry owns and operates, the pressure brought by the public interest groups is usually directed not at the industry concerned but at the governmental authorities that can influence or control the private waste manager. If industry wishes to get what it sees as its fair share of the waste management market I suggest it may well have to satisfy these concerns of reimbursement for public loss and property damage, extremely long term management ofsites lasting decades or more.

Akin to these concerns are the problems of adequate research and funding the personnel required. Adequate research more and more is coming to mean that the bulk of general research andparticular site testing has to be done before the project is approved and started. The result is that more money will be spent in a speculative way with no guarantee of success, much like in oil and gas exploration. Again this works against the small operator working alone, and of course, favours government intervention from a strictly economic point of view.

I suggest to you this also means that if industry wishes to remain in the fore it will have to spend larger sums on in house technology and personnel, or the consulting firms will have to grow larger, with less dependence on government expertise. In my second example - where the company had virtually no real assets - the proponent relied very heavily on government expertise all along the way. It received feedback from government approval agencies at all stages and was supported at public hearings by a large contingent of government lawyers, engineers and other experts. In that context it isn't surprising that the local residents and many municipal officials felt that a waste site of such size and complexity should be government run. The result is that proponents will have to become more financially substantial, be willing to spend larger sums on technical expertise and spend more risk capital venture money for general research and specific site testing. All of this with the knowledge that it takes time for public input and involvement which is also required if co-operation and trust is to be built up.

Another large step to encouraging public confidence in and acceptance of waste treatment facilities is the process of pre-application consultation with the local community and government officials. In the first two examples I used not only were the local citizens against the project but local government and municipal authorities were also negative. This was in no small way the result of lack of information and lack of local involvement until the hearings stage commenced. In the present South Cayuga proposal local involvement and access to information on all aspects of the project has improved substantially - although not as much as many would like. The result has been a noticeable reasoned approach to the whole project by citizens and municipalities alike, and very little talk of the "backyard syndrome".

The attitude that seemed to be prevalent a few years ago and which is still around now to a lesser degree that the less people know beforehand the less likely the project can be stopped will not work anymore. The public is more sophisticated and has a better understanding of waste disposal problems. The legislation enacted in this province since The Air Pollution Control Act of 1967 has, subject to some glaring exceptions, fairly well ensured that any major waste treatment facility will be subject to not only government agency scrutiny and approval procedures but also public hearings with investigation of the project, the technical processes used, site suitability, the adequacy of long term site maintenance and the adequacy of public liability safeguards. With this in mind I believe proponents will be well advised to begin the public process as early as possible to foster public participation and confidence. Hiding plans and proposals to the last minute, if even beneficial, is now self-defeating because of legal requirements for approval and general citizen interest. Openness avoids the feeling that local people are unfairly and arbitrarily being put upon from the outside.

As well, local municipal authorities with jurisdiction over roads, land use planning and zoning resent being consulted at the end of the process, being notified of detailed plans only days before public hearings commence. In my second example at Nanticoke one of the main complaints of the Regional Municipality of Haldimand-Norfolk, the senior government in the area, was that it was not involved in the proposal process by either the Ministry or the proponent. This despite the jurisdiction of the Region over the Official Plan for the area in the lands on the site, its involvement in zoning and ownership of roads for access to the site. Local people felt their control over land use and roads threatened without due consultation or allowable input.

In all three examples the site chosen was already zoned by local authorities for non-industrial uses. In the second or Nanticoke example properly zoned lands - an extremely large industrial park complex - was less than 2 miles away. It would appear that the difference in land cost contributed to the site chosen and later rejected at the hearings.

Not only should the local citizens and government be involved early on in the process but industry should be more positive in its approach to waste projects. Everyone agrees we all help produce the waste and everyone agrees we must dispose of and destroy the wastes here in Ontario. Yet the industry appears to be self-conscious of itself and always in a defensive posture. Industrial waste management is after all a necessary commodity in the modern marketplace and it should be "sold" with confidence and openness. Above all the industry should not take a condescending attitude towards public participation and knowledge. I can remember one public meeting involving the deep well disposal application in my first example where a series of fairly technical questions was asked of a panel member at a public hearing by a member of the audience. Eventually the panel member told the questioner that he wouldn't respond because if he gave answers they wouldn't be understood anyway. The questioner was a local resident, but he was also a qualified engineer who had been involved in building some of the biggest petro-chemical plants in the world, including some in Jamaica, Africa, Newfoundland and other parts of Canada and the United States, working for a variety of multi-national corporations. One of his main concerns in these projects had been dealing with product residue and plant effluent. Enough said.

One of the advantages for proponents in releasing information early on in the application process and in having a fair regard for public intelligence is that total time to put a project in place will be reduced. Hearings will proceed more quickly and smoothly if the relevant test results and design data are easily and early available. In the second or Nanticoke example some of those opposing the application obtained very confident consulting engineers to assist them at public hearings. Unfortunately, the data they needed to properly assess the proposal was available on a relatively piecemeal basis and mostly during the currency of the hearings. Too often in the past data and information could only be dragged out of proponents at the public hearings level resulting in delays and the general feeling of mistrust by local residents and elected officials. Again early access to information should help proponents obtain faster processing of the proposal and greater credibility with those most directly affected.

In my view a company acting with enlightened self-interest would be best advised to co-ordinate its efforts with all levels of government early on in the process, make meaningful data available before hearings to the local public interest groups and municipalities. It would also have fully prepared itself by finalizing design and substantially completing site testing before hearings commence.

This approach is already evolving. When industrial liquid waste management really got rolling it was essentially something developed and put into place by one company or group without outside monitoring. Then through a variety of governmental legislation the developer had then to deal with government regulatory agencies such as the Ontario Ministry of the Environment in order to have the system approved before it was put into place. The evolution of The Environmental Assessment Act, The Environmental Protection Act and The Ontario Water Resources Act hearing process to its present state means essentially that the developer or proponent now has to bring the local people and municipalities into the entire process either at the hearing stage with resulting delays or hopefully earlier.

Finally I'd like to address a few remarks to a relatively new development in the environmental law process. As I'm sure most of you are aware, The Environmental Protection Act of 1971 and The Environmental Assessment Act of 1975 and other similar acts set up a course of conduct for proponents to obtain provincial approval for waste treatment projects. These acts include as part of the process public hearings on the merits of the application complete with basic ground rules for those hearings. I want to avoid being partisan at this point - I have not come hear to pleadany particular cause - but in very general terms I would like to make the comment that all of these rights these acts confer on interested parties and governments should remain unaltered, or those rights should be permanently removed from the legislation so that everyone knows what the rules are and where they stand.

From the public point of view the use of governmental discretion to terminate some rights some of the time - such as the right to hearings under these acts - is never acceptable and in the long run is probably counter-productive. For one thing the use of exception provisions make the whole process look unfair to the ordinary law abiding man on the street who "plays the game" by the rules. The ordinary person cannot in urban areas lawfully burn his garbage in his back yard; he cannot put his cattle, chickens or hog barns too close to other structures; he cannot choose his own septic system in many rural areas; he cannot remove anti-pollution devices from his automobile. These rules are set down and most people abide by them even if they do not agree with them. It becomesvery difficult to convince people that their rights are still being safeguarded when a proponent - in this type of case usually a government - exempts itself from its own regulations and laws. The essential feeling of fairness we all look for is threatened by this process.

It also becomes all that more difficult to convince people that despite no hearings, or the loss of some other right, that the proposal represents state of the art technology being placed on a site as safe as science and engineering can make it. From here it is an uphill battle to foster general local support for any project. In short, it appears unfair to the ordinary citizen that the rules of the game are changed after the game is started but before it's finished resulting in loss of credibility for the proponent and the project.

Taking a strictly practical approach it appears that in the long run such exemptions from legislative safeguards result in little benefit anyway. If I can refer to the South Cayuga town site proposal briefly I point out that despite the fact there will be no opportunity for Environmental Protection Act, Environmental Assessment Act and Ontario Water Resources Act hearings some form of public hearings will take place. It now appears those hearings will be a 3 stage process over a period of a year or more. It is extremely doubtful if any time or money will be saved by the alternative approach. It may be that other less obvious benefits may accrue to the proponent, but I said I would attempt to be non-partisan here today and I will make no further comment in that regard. In summary I would ask you not to underestimate the good faith of the local citizen in his community. Most people are prepared to be reasonable and are now sufficiently sophisticated to know and understand that industrial waste is a problem that we must solve ourselves and it is a problem for which we all bear responsibility. If that average person is treated with fairness and his intelligence is respected then waste treatment projects that have genuine merit will be acceptable even to those who are most closely related to it. It is my view that a review of waste management applications and projects over the last 10 years or so will demonstrate that access to information, encouragement of local involvement from the early stages, a consistent approach to the legislation and the use of state of the art technology will put to rest many of the problems that those in the liquid waste management industry have encountered in the past.

A Progress Report on

Ontario's Waste Management

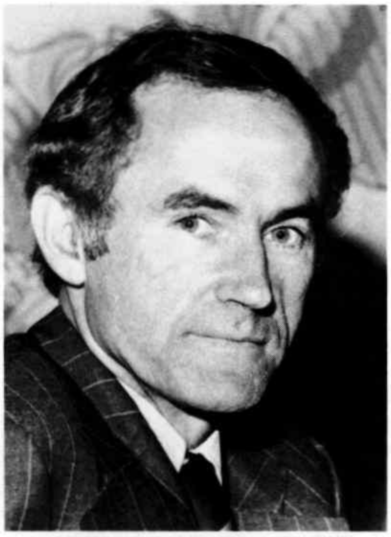
Program

by

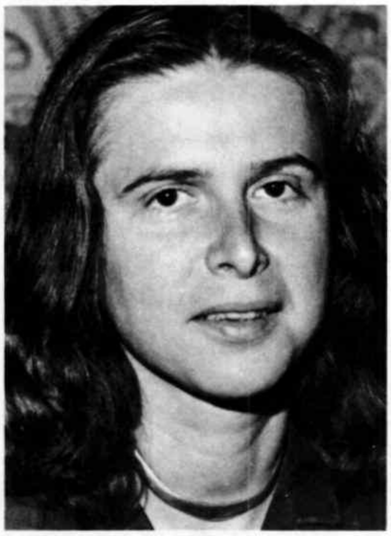
G.W.S. Scott, QC,
Deputy Minister
Ontario Ministry of the Environment

Note: Mr. Scott spoke from notes and personal experience. He did not have a formal text prepared which could be included in the Proceedings.

SESSION V – ENVIRONMENTAL PERSPECTIVES



Chairman: G. C. Ronan, Director, Laboratory Services Branch, Ontario Ministry of the Environment



M. Campbell, Researcher, Pollution Probe, Toronto, Ontario

E. F. Winter, Superintendent of Process Technology, INCO Ltd., Port Colborne, Ont.

T. Ellis, Land Specialist, Ontario Centre for Remote Sensing, Ministry of Natural Resources, Toronto

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OPPORTUNITIES FOR HAZARDOUS

WASTE REDUCTION AND RECOVERY

by

Moni Campbell

Pollution Probe

OPPORTUNITIES FOR HAZARDOUS WASTE REDUCTION AND RECOVERY, PARTICULARLY AS IT RELATES TO SMALL AND MEDIUM SIZED BUSINESS

Back in the old days at Pollution Probe when we were involved in domestic garbage issues, we used to say," Recycling garbage without diminishing the quantity of garbage produced is as futile as dieting by running 10 miles a day while munching on chocolate eclairs!"

We've graduated from municipal garbage and chocolate eclairs to more pressing problems such as that of hazardous waste. And yet much of that old wisdom remains timely in the sound management of wastes today. Cutting back on the production of wastes makes sense in terms of economics and resource conservation for both domestic and industrial wastes.

At present, Canada's research dollars and research time are overwhelmingly oriented towards making advances in waste disposal technologies. With stockpiles of waste barrels growing rapidly, authorities feel caught in the frenzy of dealing with the narrow issue of seeking better disposal methods. Although the deployment of better waste disposal technologies will result in better management of our wastes, it does little to shrink the volumes of waste being generated.

The increasing attention focussed on the landfill disposal option offers serious competition with the fledgling field of waste reduction and recovery. This narrow focus has had the unfortunate

impact of undermining the development of technological advances in the reduction and recovery of hazardous wastes.

Ontario produces about 60 million gallons of industrial wastes each year (liquid industrial wastes). This represents about half of the wastes produced by Canada as a whole.

Of Ontario's 60 million gallons of liquid industrial wastes, 40% are oil and water mixtures, 30% are waste oils, solvents and paint sludges, 29% are waste acids and alkalis. That leaves 1% as halogenated solvents, PCB's and miscellaneous inorganics.

Ministry of Environment officials estimate that only 10% of these wastes are 'hazardous'. Although the industrial waste stream may be contaminated with some very hazardous chemicals, a large part of that waste stream is relatively innocuous, and in most cases of great re-use potential.

The technology exists, and is in place in some facilities to separate oil/water mixtures for re-use. The technology exists and is in place in some facilities to recycle waste oil and solvents. With 70% of Ontario's industrial waste stream composed of oil/water mixtures, waste oils and solvents, the potential for waste re-use and recycle in Ontario is enormous.

In fact, I would go so far as to suggest that the technology for reduction and recovery is advanced over the technology to safely dispose of industrial wastes. Even design engineers will not guarantee that "secure" landfills are immune from leaking.

In the past, industry has viewed environmental protection and economic development as incompatible. Pollution control expenditures were seen as simply an additional cost that brought no benefits. At best, pollution control was thought to be a waste of money, and at worst a major cause of inflation.

Since then, some businesses have recognized that reducing pollution and improving company profits go hand in hand. Tired of being known as "environmental bad guys", some companies have actively re-assessed their production methods and undertaken a systematic approach to reducing pollution.

Certain companies have learned to "make pollution prevention pay" by striving for "zero waste technologies". The term "zero waste technology" is not to be taken literally. It is clear that it is technologically impossible and economically infeasible to completely eliminate the production of a residue from any pollution abatement measure. Users of the expression "zero waste technology" are instead referring to an approach which includes such means as designing closed-loop technologies, or transferring wastes as inputs into other business sectors.

Unlike the more conventional "end-of-pipe" treatment technologies that eat up resources and yield a sludge problem, "zero waste technologies" strive to minimize the volume of residuals produced while conserving material and energy resources.

No one can deny that pollution control costs money. The question is, can pollution reduction be profitable in the longer term? Although conventional "end-of-pipe" treatment technologies can constitute an investment without a return, the converse is usually true for closed-loop approaches.

By recognizing waste for what it is-- a waste of materials -- it is seen that shrinking and/or recovering these otherwise wasted resources can yield financial returns.

The following slides will demonstrate how some industries have turned pollution prevention into a profitable venture. Examples are shown from the oil recycling industry, printing industry, photofinishing industry and the electroplating industry.

Oil Recycling (summary)

Chem-Ecol Ltd (Cobourg, Ontario) is a small well established independent oil recycling operation specializing in custom recycling of industrial oils such as hydraulic oils and cutting oils. Contaminants are removed from the waste oil, additives are put in and the cleaned oil is returned to the customer at typically half the cost of new oil.

The operation at Chem-Ecol is a good example of small business "imagineering". Five years ago when the outfit set up shop, the company president scavenged scrap yards to put his system together. Components for the vacuum heater, for example, were bought for $2,000 from a scrap dealer. Replacement cost today would be about $50,000.

Printing Industry

The Toronto Star (Toronto, Ontario) whose ink recycling system has been operating since May 1978, was the first Canadian newspaper to undertake this type of recycling program. Prior to installing the ink reclaimer, the Star was paying $15,000 a year for ink disposal.

In the first eight months of operation, the Star's $28,000 system cut disposal costs to zero and produced enough recycled ink to replace $40,000 of new ink.

In addition, filtered ink is often better than new ink received from manufacturers. The recycling process produces an ink with smoother flow properties, better absorbency, faster drying characteristics and smaller, more uniform particle size.

The Star no longer has to dispose of any ink, no printing quality problems have resulted from using the system, and there have been few maintenance problems.

Photofinishing Industry

3M Photofinishing Labs (Toronto, Ontario) are one of many photofinishing labs in Canada that recover silver from process waters. 3M has designed its own silver recovery unit which it calls the Silver Saver.

Spent fixer is circulated through the Silver Saver which by electrolysis causes 98% pure silver to be deposited onto a central rod.

The Silver Saver is another example of in-house "imagineering" - instead of buying costly commercial units, 3M designed and built its own silver recovery units from "bits and pieces of pipe and plastic". At its Toronto plant alone, 3M recovered $650,000 worth of silver in the last year. Little more than a decade ago, all of this silver would have been lost to the city sewer system.

Electroplating Industry

Eco-Tech Ltd (Toronto, Ontario) is out to show that pollution control doesn't have to be an unprofitable investment. Eco-Tech adapts its PARR (Pollution Abatement via Resource Recovery) system for automotive plastic plating shops to recover process chemicals, reduce water consumption and generally reduce pollution loadings in the wastestream.

Plastics Company (Peterborough, Ontario) is a small company that plates chrome onto plastic car parts such as grills. Despite an initial investment of $400,000 (10% of the total plant cost) on the Eco-Tech Pollution abatement equipment, the system is anticipated to save the company money in just two years through reduced sludge disposal costs and increased materials recovery of copper, nickel and chrome. Plastics Company staff estimate that by using the Eco-Tech equipment, the company now produces only one fiftieth of the sludge it would have produced without the Eco-Tech equipment.

In summary, the pattern is clear. Minimizing pollution at source makes the company a two-time winner: once because of reduced disposal costs and once again becuase of reduced costs in the purchase of materials inputs.

REMOTE SENSING IN POLLUTION ABATEMENT

by

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ABSTRACT

Remote sensing techniques are proving very useful for a broad range of environmental applications. They offer the advantage of the acquisition of data from ranges of the electromagnetic spectrum other than the visible and provide a permanent record for verification and historical reference. In addition they are generally more cost-effective than surface survey and sampling methods.

Aerial thermography in particular has proven successful in the detection and monitoring of environmental pollution such as industrial thermal plumes, oil spills, ground water discharge points and sanitary landfill sites.

Through the co-operative efforts of environmental protection personnel and remote sensing scientists, the development of many more applications of remote sensing to environmental concerns can be expected in the future.

INTRODUCTION

As the population density, level of technology and economic activity of a society increase, so also do the quantity and variety of pollutants generated by the industrial, agricultural and residential sectors. Pollutants may range from being merely undesirable such as an offensive odour to those which may cause serious illness or death to human, animal and plant life. Nevertheless, society expects these wastes to be diluted and dispersed by rivers, lakes, oceans and the air or held locally in landfill sites without creating any extended contamination.

Improving or upgrading the environment is high on the priority list of a concerned society. By simply looking at a body of water, the air, or an area of land, a general quality assessment can sometimes be made but more accurate assessments of environmental quality

are possible with the use of remote sensing. Using modern remote sensing techniques, society has the potential for recording necessary information about the input and diffusion of pollutants in our waters, on our land and in our air.

Remote sensing is, literally, the perception of objects from a distant vantage point. It has been used for many years as a means of detecting and monitoring many different types of environmental pollution. The science of remote sensing is based on the fact that patterns of energy (such as ultra-violet, visible and infrared light, heat energy or other forms of electromagnetic energy) coming from the earth's surface, reveal some of the characteristics of the objects on the earth's surface (OCRS, 1979).

Remote sensing involves the recording of energy patterns from the surface of the earth by means of sensors carried in aircraft or satellites. These sensors can be photographic cameras, video cameras or electronic scanners. The recordings made by these sensors may be in the form of pictures known as imagery or in the form of numerical data stored on tapes.

As a technique for gathering information, remote sensing has a number of specific advantages over more traditional field data collection methods. The primary advantage is that a permanent recorded image is acquired of a scene or area of interest. This permanent record can then be studied by an interpreter in the office or in the laboratory at any time. Analysis of the data can be aided by optical, mechanical or electronic devices not available to the field data collector whose analysis of an area must be done from tally sheets and records of visual information obtained on site. In addition, the availability of permanent recorded images and the ability to obtain repetitive area coverage using the same parameters allows the monitoring of an area to take place.

Another advantage is that remote sensing techniques allow the acquisition of data from ranges of the electromagnetic spectrum other than the visible. There are many conditions in the environment that are not visible to the human eye but are detectable by other types of sensors. Remote sensing techniques allow us to obtain data about conditions that would otherwise remain undetected and unknown until they had manifested themselves in visual form.

The fact that remotely-sensed images are acquired, for the most part, from the vertical perspective, results in the third advantage of a synoptic view of an area so necessary for interpretation and analysis. The use of remote sensing techniques can thus reduce the need to perform costly and time-consuming surveys on the surface of the earth itself and can increase the effectiveness of selective field checking.

One remote sensing technique which appears to be a most promising tool in the detection and monitoring of environmental pollution is aerial thermography.

THERMOGRAPHY

All objects on the earth's surface radiate heat energy in proportion to their temperature. Ice and snow radiate less energy than a soil surface in summer but even the amount of energy coming from a frozen lake can be detected, measured and recorded through the electronics of thermal imaging systems.

Not all objects radiate heat energy (also called thermal infrared energy) at the same rate. This is due in part to the chemical and physical characteristics of the materials involved as each material has its own emissivity and two different surfaces, at the same temperature, emit different amounts of radiant energy because of their emissivity differences. A thermal sensing system produces images of radiant temperatures, therefore, not true temperatures.

The size and sensitivity of the detecting element in a thermal sensing system governs how fine a temperature difference and how small a distinct ground area the unit can detect. The thermal line scanning system used by the Ontario Centre for Remote Sensing employs two 1.7 millirandian detectors sensitive in the 3 to 5 and 8 to 14 micrometer wavelength ranges. The detectors average the incoming radiation from an instantaneous field of view on the ground of approximately 1.7 metres square per 1000 metres of flying altitude above the ground. The system is sensitive to radiant changes of 0.2°C with an absolute accuracy of 0.5°C.

The scanning mirror sweeps the ground at a rate of 80 scans per second. During each cycle the mirror views two adjustable temperature references on the scanner as well as providing a field of view of 77° 21' beneath the aircraft.

The thermal line scanner converts the radiated heat energy emitted from the earth's surface into electronic signals. These signals are recorded on magnetic tape and played back on a screen similar to that of a television. Working prints for use in interpretation are produced by electronically exposing photographic film. These pictures, or thermographs, look somewhat like the familiar black and white aerial photograph at first glance. On the thermograph, however, the light and dark tones represent relative levels of warmth corresponding to the temperature patterns of the ground being viewed. On positive prints of the imagery, relatively warm areas are shown as lighter shades of grey while colder areas are darker.

As thermography records only the heat energy emitted by a feature, the ability to study the feature does not depend on the availability of visible light. The acquisition of thermography is, therefore, not necessarily limited to daytime or to a time of year. Thermography missions are conducted at a time when the object of study is in maximum temperature contrast to its surroundings. The temperature contrast may consist of a 'hot' subject against a cold background or a 'cold' subject against a warm background.

APPLICATIONS

Industrial Thermal Plumes

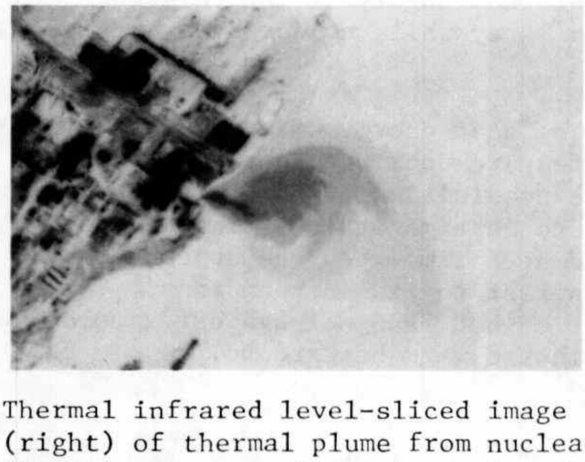
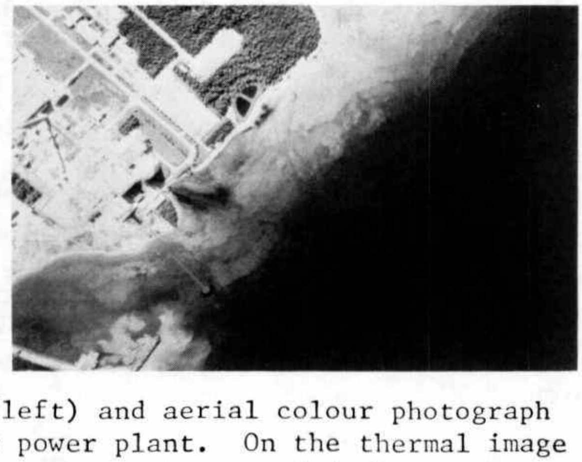
Water is withdrawn from lakes, rivers and the oceans to be used as a coolant in many industrial processes. Nuclear and fossil-fuel electric power plants, refineries, chemical and steel plants use large volumes of water. Apart from any chemicals or suspended matter that may be in the returned water, the heated water itself can affect the environment in a number of ways. Excessively high temperatures may kill or inhibit growth and reproduction of certain organisms and, conversely, it may promote the growth of others such as algae. In addition, heated water has a lower content of the dissolved oxygen that is essential for aquatic life and for the process of oxidizing wastes (Sabins, 1978).

Thermal discharges into lakes and rivers are, therefore, of interest to both the industrial planner and the environmentalist. Increasingly, thermal pollution has become a major problem for urban and rural areas.

Thermal infrared imagery is frequently used for the study of industrial and municipal discharges to detect sources of thermal pollution in waterways and to monitor the dispersion patterns and flow of heated water into receiving waters (Reeves, ed. 1975).

Conventional means of monitoring plumes are usually time-consuming and costly. Aerial thermography can image the plume by virtue of its temperature differential from the ambient water. The imagery shows at a glance the areal distribution of the plume. In addition, the thermal gradient across any section can easily be determined since it is possible to relate the various densities of emulsion on the image to the radiant surface temperatures of the plume.

Airborne thermal plume monitoring is a passive technique which does not disturb or interact with the plume in any way. This technique may be employed during the day or at night with equal success. Thermal infrared surveys are an ideal way to monitor the temperature and pattern of the discharge outfalls.

Thermal infrared level-sliced image (left) and aerial colour photograph (right) of thermal plume from nuclear power plant. On the thermal image light tones are relatively cool radiant temperatures and dark tones warm.

Oil Spills

The large number of oil spills that occur annually throughout the world, the growing number of supertankers that carry oil and the astronomical costs in terms of clean-up, wildlife loss and esthetics are likely to make the use of thermography to detect and monitor oil spills increasingly common.

Although ultra-violet imagery is one of the most sensitive remote sensing methods for the monitoring of oil on water, daylight and a clear atmosphere are necessary to acquire this kind of imagery. The day and night capability of thermography makes it a valuable technique for surveillance and monitoring of clean-up operations.

As documented by Sabins in 1978, on thermal infrared imagery, both refined and crude oil films have cooler signatures than the adjacent clean water. When oil and water are in direct contact the two liquids have the same true temperature but an oil film has a lower radiant temperature than pure water because of differences in emissivity.

For pure water and an oil film at the same true temperature of $18^{\circ}C$ there is a $1.6^{\circ}C$ difference in radiant temperatures between the two liquids. This difference is readily detected by thermal infrared detectors that are sensitive to temperature differences as small as $0.2^{\circ}C$.

The laser fluorosensor, though still in the prototype stage, promises to be an even more sensitive remote sensing technique for the detection and monitoring of oil spills. It will ultimately provide the means to characterize a particular oil spill with the aim of identifying its origin.

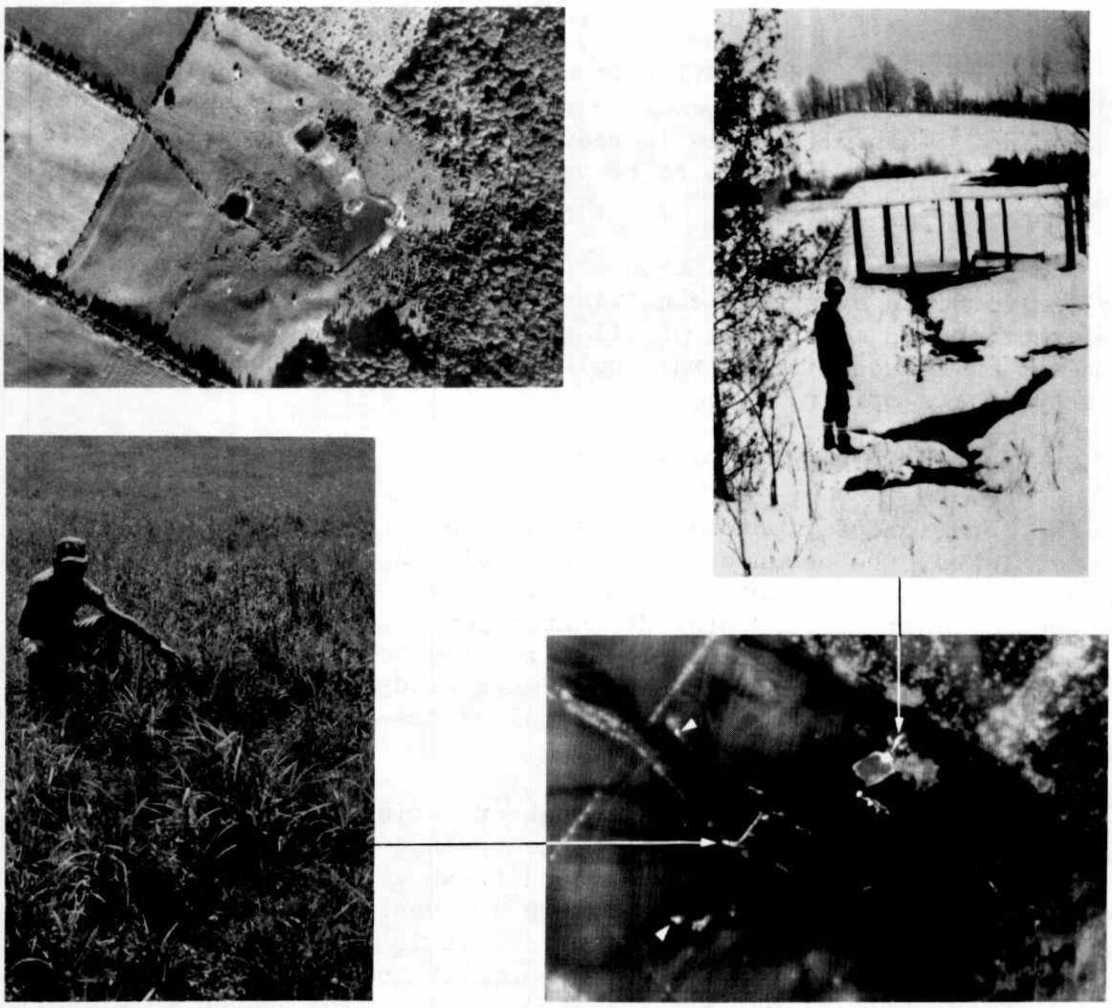
Groundwater Discharge Points

The location of groundwater discharge points, whether into streams, lakes, the ocean or simply as isolated springs, has received much emphasis in the remote sensing community over the years. The knowledge of where groundwater discharge points are located enables the land use or environmental planner to make sound decisions as to the placement of industrial wastes, sewage sludge, agricultural residues, mining refuse and pathological wastes from institutions such as hospitals and laboratories.

Thermal imagery can be used to detect springs and seeps when the temperature of the groundwater from the spring or seep differs significantly from that of the surrounding area. Ground water maintains a relatively constant temperature all year round. Since the water comes from below the ground surface it is not greatly influenced by surface climate. Spring water is normally cooler than the surface water into which it flows in summer and usually warm enough in winter to keep local surface water free of ice.

The optimum conditions for thermal scanning to locate groundwater discharge points occur after winter freeze-up when all water bodies which are not near a discharge point will be frozen. During this time a cover of snow over the ground acts as a thermal blanket. The surface of the snow masks temperature differences which may occur between ploughed fields, pastures and forests because of different heating and cooling properties. The coldness of the snow cover allows the warm springs to stand out on the thermographic imagery as intense hot spots against the thermally-flat background (Lawrence et al, 1980).

A vast majority of cases of damage to life and the environment documented by various government agencies in North America involve pollution of groundwater from improperly sited or operated landfill locations and surface impoundments (pits, ponds and lagoons). By using aerial thermography, groundwater discharge points can be located and steps taken to ensure that land uses in these areas do not become sources of pollution of the groundwater.



Groundwater Discharge Points: B/W photograph (1:12,000) at upper left; ground colour photographs (winter and summer); contact thermography print at lower right.

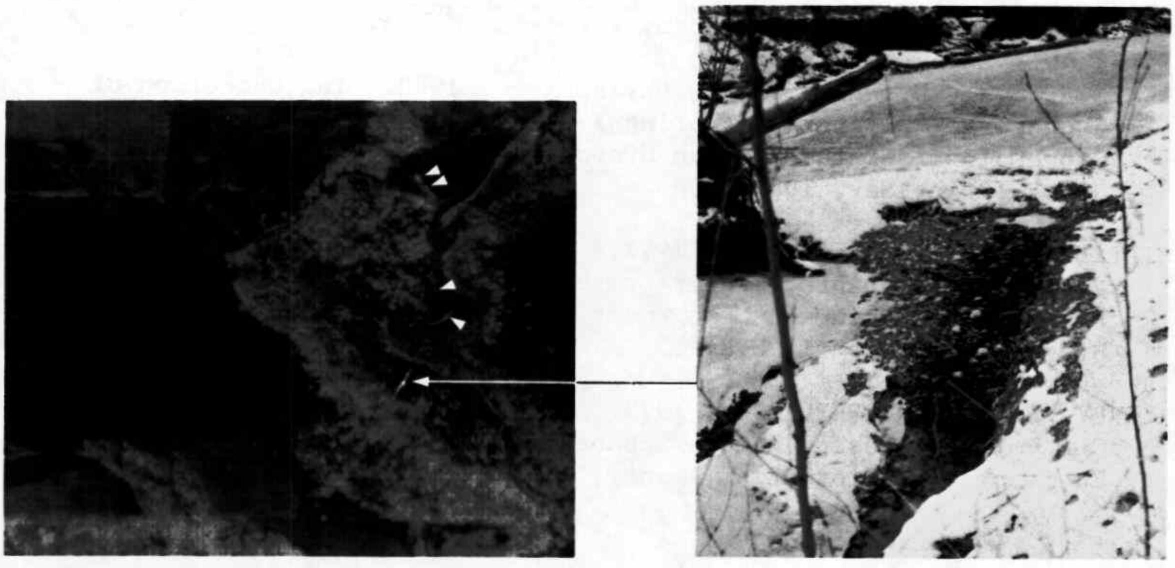
Sanitary Landfill Sites

Concern about the effects of sanitary landfill sites on the environment has been increasing in recent years. As indicated by Philipson et al, 1977, and Sangrey et al, 1979, landfilling is a common and appropriate means of disposing of a wide variety of solid waste. The major advantages of landfill disposal methods are low cost and convenience. There is a lack of acceptable alternatives. Among the major disadvantages is the potential production of leachate, an extremely variable liquid resulting from waste decomposition and water percolation and flow through the waste. If not controlled, leachate can flow out of the landfill as part of, and as a contaminant of, the ground and surface water regime.

For planning remedial measures to control leachate from an existing landfill, all points of potential contamination must be located. This task is difficult and time-consuming and can be inaccurate if conducted solely through field surveys, especially since leachate outbreaks may occur at relatively long distances from the landfill.

Leachate normally maintains a temperature the same as the sub-surface temperature of the landfill. At certain times during the year the surface of a landfill has a cooler temperature than the internal portion of the landfill. Leachate flowing from a landfill under these conditions will be warmer than its surroundings and will have a "warm" signature on thermal imagery taken at this time.

Although ground sampling and laboratory analysis are still required to confirm leachate contamination, remote sensing techniques such as aerial thermography provide an effective means of detecting potential locations of leachate outbreak.



Contact thermography print (left) and ground photograph (right) of suspected leachate outbreak at a sanitary landfill site. Other potential outbreaks are also indicated.

Other environmental applications of thermography that are cited in the literature include environmental impact studies, urban microclimate and volcano studies, subsurface hydrocarbon pipeline leak detection and the detection of sewage disposal pollution and septic tank seepage in waterways.

SUMMARY

The application of thermography and other remote sensing techniques is proving very useful for a broad range of environmental applications. Remote sensing techniques are generally more cost-effective than surface surveys and sampling methods, and offer the advantage of a permanent record for verification and historical reference. Remote sensing techniques are not yet applied to the extent which their advantages would suggest, however, the major problem being the fact that potential applications are still not widely known or their significance understood. Only the co-operative efforts of environmental protection personnel and remote sensing scientists can overcome this barrier to the use of this practical, new tool.

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EFFLUENT TREATMENT AT INCO'S PORT COLBORNE NICKEL REFINERY

BY

E. F. Winter

P. G. Garritsen

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ABSTRACT

EFFLUENT TREATMENT AT INCO'S PORT COLBORNE NICKEL REFINERY

E. F. Winter* P. G. Garritsen** H. R. Butler***

Inco Metals Company, a unit of Inco Limited, operates a nickel refinery at Port Colborne, Ontario, adjacent to the Welland Canal on Lake Erie. In 1968, Inco decided to consider means to reduce the contaminant level in the plant effluent. To achieve the desired results, a number of studies and pilot plant processes were conducted. The studies included hydrology, ion exchange, and chemical precipitation, in conjunction with clarification and filtration. On October 17, 1980, a modern plant was formally opened to provide treatment of up to 2170 m^3/h of effluent which consistently meets Ontario Ministry of Environment criteria. The treatment consists of lime induced precipitation followed by clarification in two 21.3 m diameter solids-contact clarifiers. The sludge is filtered and shipped to Inco's Copper Cliff facilities.

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EFFLUENT TREATMENT AT INCO'S PORT COLBORNE NICKEL REFINERY

INTRODUCTION

The Inco Metals Company refinery in Port Colborne, Ontario, was built in 1918, beside the Welland Canal, on a Lake Erie lakefront site suitable for its proximity to markets and to Niagara Falls and the hydro-electric power generated there. The Port Colborne site shares nickel refining duties with company facilities in Thompson, Manitoba and Copper Cliff, Ontario. Three Research Stations located at Port Colborne have pioneered new nickel refining procedures and continue in the forefront of the industry's research. The main products of the refinery are electrolytic nickel and furnace products such as Utility Nickel and various alloys from the Foundry Additive Plant.

The treatment plant influent includes drainage from the 114 Ha plant property and from 41 Ha of adjacent developed residential areas. Flow records maintained over a 10 year period indicate the flow can vary from 860 m^3/hr to 3200 m^3/hr with an annual average of 1325 m^3/hr.

In 1968, the then OWRC in conjunction with Inco, conducted an extensive survey of the plant and effluent quality. This report indicated water quality to be

	Refinery Intake	Refinery Effluent
Nickel (mg/l)	0	4.8 - 13.2
Copper (mg/l)	0	.2 - 5.9
Susp. Solids (mg/l)	7 - 13	18 - 77

As a result of this survey, Inco embarked on a program to reduce the contaminant level in the plant Effluent.

PROGRAM DEVELOPMENT

When Inco's evaluation of the 1968 OWRC report had been completed, the problem was addressed for both the short term and the long term reduction of contaminant levels.

During the period of June 1968 to July 1973, there were some 14 in-plant modifications made which reduced the nickel loading in the effluent some 45 per cent to 216 kg per day. However, these modifications did not meet the then OWRC guidelines of 1. mg/l nickel.

Concurrently, a consultant was engaged to conduct a feasibility study and cost estimate of a treatment facility. During and subsequent to the study, Inco staff reviewed the potential of ion exchange and various physicochemical processes. On the basis of these internal studies, further work was recommended.

PILOT PLANT STUDIES

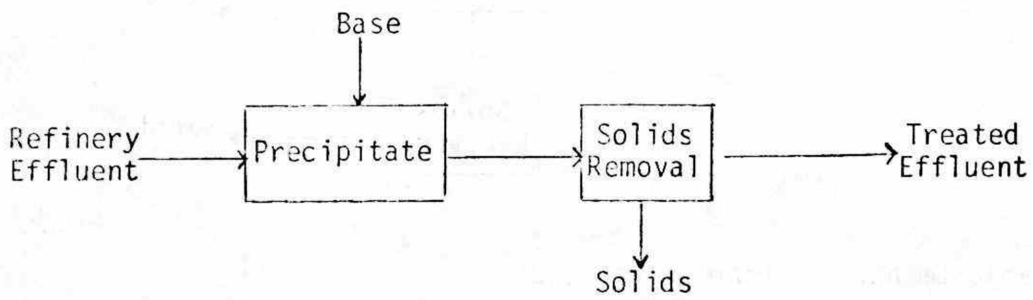
Early in 1973, Inco Process Research in Port Colborne commenced exploration testwork on the Port Colborne Nickel Refinery effluent to determine the process options available to meet specifications of less than 1 mg/l Ni and 15 mg/l suspended solids. The effluent averaged about 6 mg/l total nickel, of which 4 mg/l was soluble nickel, and 30 mg/l

suspended solids.

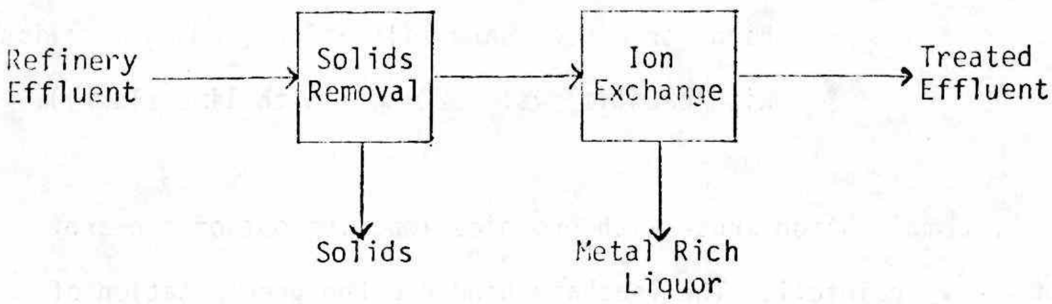
Through bench scale tests, it was established that the soluble nickel could be precipitated by raising the pH from about 7 to 10.5. This then left two main options available to treat refinery effluent having the following analyses.

pH	Cu	Ni	Fe	Suspended Solids
8	0.3	6	1.3	30

1. Precipitate soluble nickel and remove the solids by mechanical means.



2. Remove suspended solids by mechanical means and the soluble nickel by ion exchange.



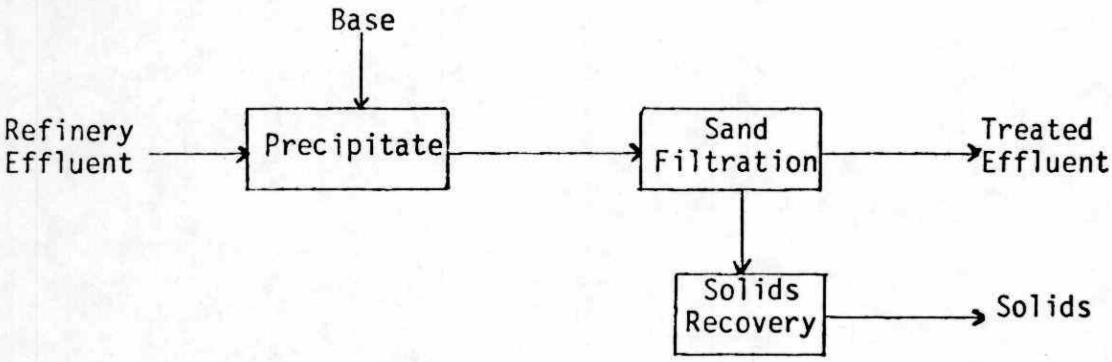
At this point, the success of the treatment plant at Inco's Copper

Cliff Works indicated that physicochemical treatment was the more cost effective methodology. It was decided to concentrate on this metholology rather than ion exchange.

The following two options were then pursued in more detail.

1. Chemical precipitation followed by filtration.
2. Chemical precipitation followed by clarification.

FILTRATION METHOD



- pH adjustment: Lime or caustic
- Solids Removal: Sand Filtration - Settling
- Sand Filtration: Direct sand filtration was only feasible with caustic adjusted effluent. The suspended solids loading with lime adjusted effluent was too high for direct sand filtration (160 mg/l solids with caustic vs. 320 mg/l with lime slurry).

A further complication arose with organics leaching out of a nearby swamp during heavy rainfall. The leachate hindered the precipitation of soluble nickel with caustic even at pH 12. With lime, however, the problem was overcome at about pH 11.

Table 1

NORMAL CONDITIONS	REFINERY EFFLUENT	LIME ADJUSTED EFFLUENT	CAUSTIC ADJUSTED EFFLUENT
pH	8	10	10
Nickel Dissolved (mg/l)	4	<0.5	<0.5
Nickel Total (mg/l)	6	-	-
Suspended Solids (mg/l)	30	160	80
Lime Consumption (kg/m^3)		0.14	
Caustic Consumption (kg/m^3)			0.12
HEAVY RAIN WITH RUN-OFF			
pH	8	11.5	12.5
Nickel Dissolved (mg/l)	5	<0.5	1.0
Nickel Total (mg/l)	10	-	-
Suspended Solids (mg/l)	60	320	160
Lime Consumption (kg/m^3)		0.36	
Caustic Consumption (kg/m^3)			6.0

After considerable testwork, with both upflow and downflow filters the conclusions were: Solids loading on the filters with lime was excessive.

With caustic: - scaling of the filters was a problem as well as during heavy runoff. During periods of heavy rain, the specifications could not be met. On the basis of this testwork, it was decided to proceed with lime adjusted pH and to test two clarification systems.

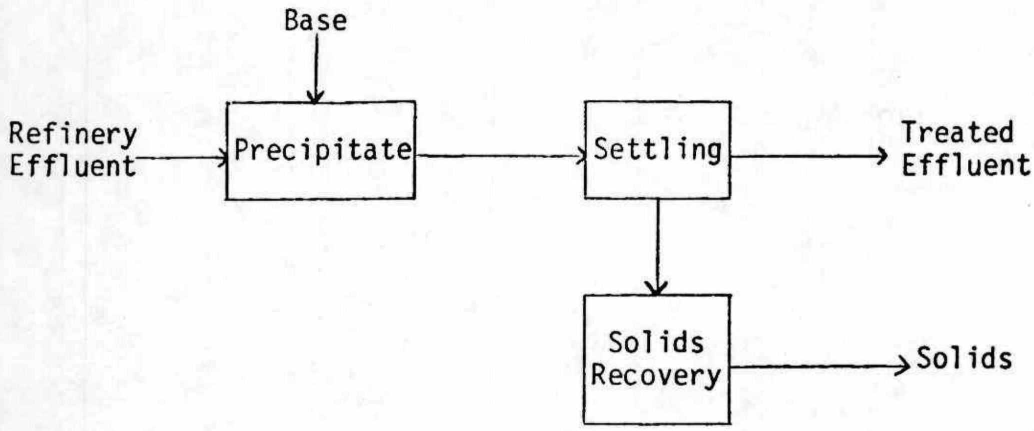
1. Tilted Plate Clarifier

2. Sludge-recirculation solids contact clarifier.

These were tested simultaneously on the same feed stream in order to properly assess the two methodologies.

Figure 1

CLARIFICATION METHOD



The Tilted Plate Clarifier - The effluent was reacted in a multizone mixing compartment with lime, polyelectrolyte and ferric iron to produce a good settling material. A tilted plate clarifier was tested with the following results.

Table 2

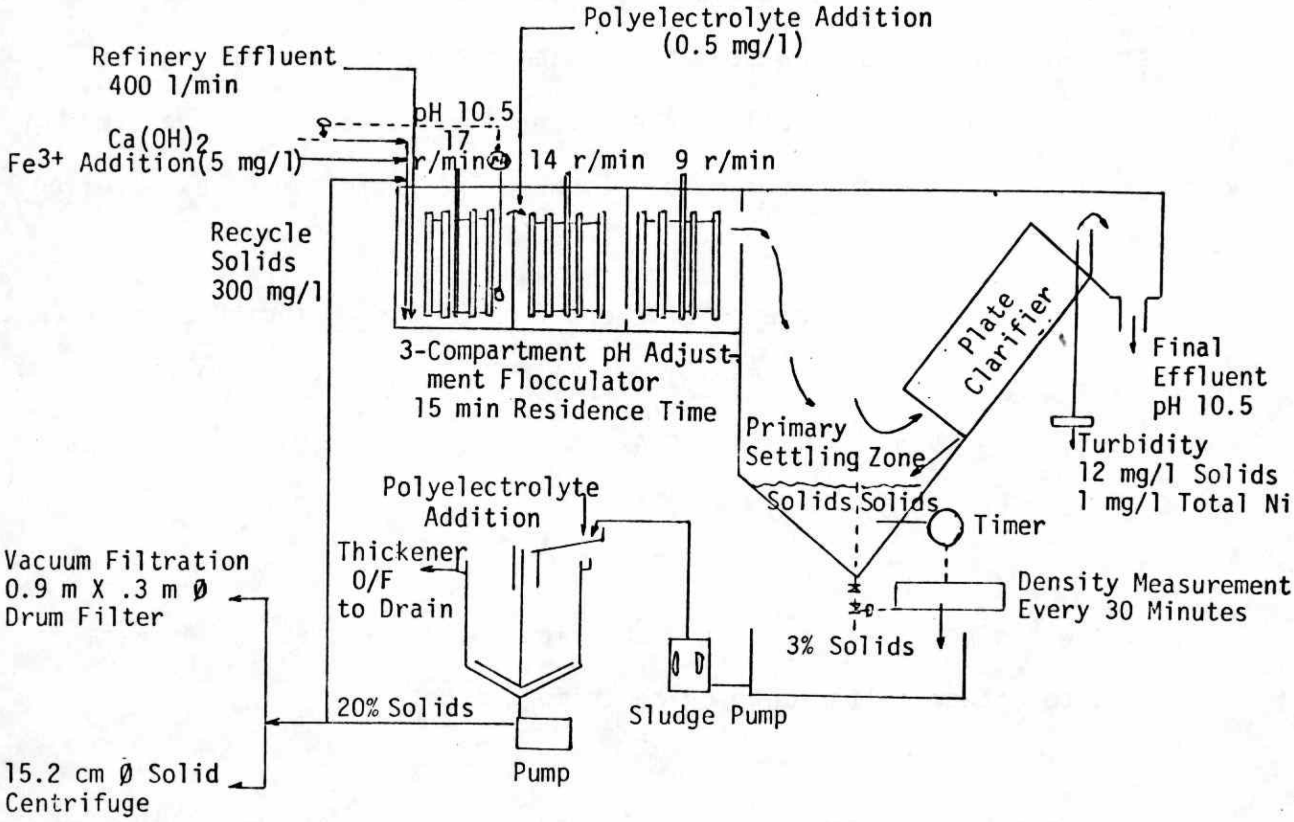
Treated Effluent

Tilted Plate Clarifier

	Nickel (mg/l)	Solids (mg/l)
May 1975	0.8	9
June 1975	0.9	10

Figure 2

TILTED PLATE CLARIFIER TEST CIRCUIT



After several weeks of operation it became apparent that scaling between the plates was excessive and a cleaning cycle was required. It was also evident that the nickel bearing solids were selectively overflowing.

The total test period was continued for 7 months to establish engineering and the required scale-up data.

The sludge-recirculation solids-contact clarifier: Employing this type of clarifier, the results were encouraging from the beginning. It became apparent that the flexibility, ease of operation and the cost comparison with the tilted plate clarifier was in favor of the solids-contact clarifier. Also the scaling problem and elutriation of solids high in nickel were practically non-existent. The circuit was operated during winter, spring and summer conditions. The performance was excellent.

Table 3

Treated Effluent from Solids-Contact Clarifier

	Nickel (mg/l)	Solids (mg/l)
May 1975	0.4	9
June 1975	0.4	8

Also with these circuits, the underflow solids of these units were processed to either filter cake or centrifuge cake.

Engineering data were also established for thickening and filtration of the clarifier underflow.

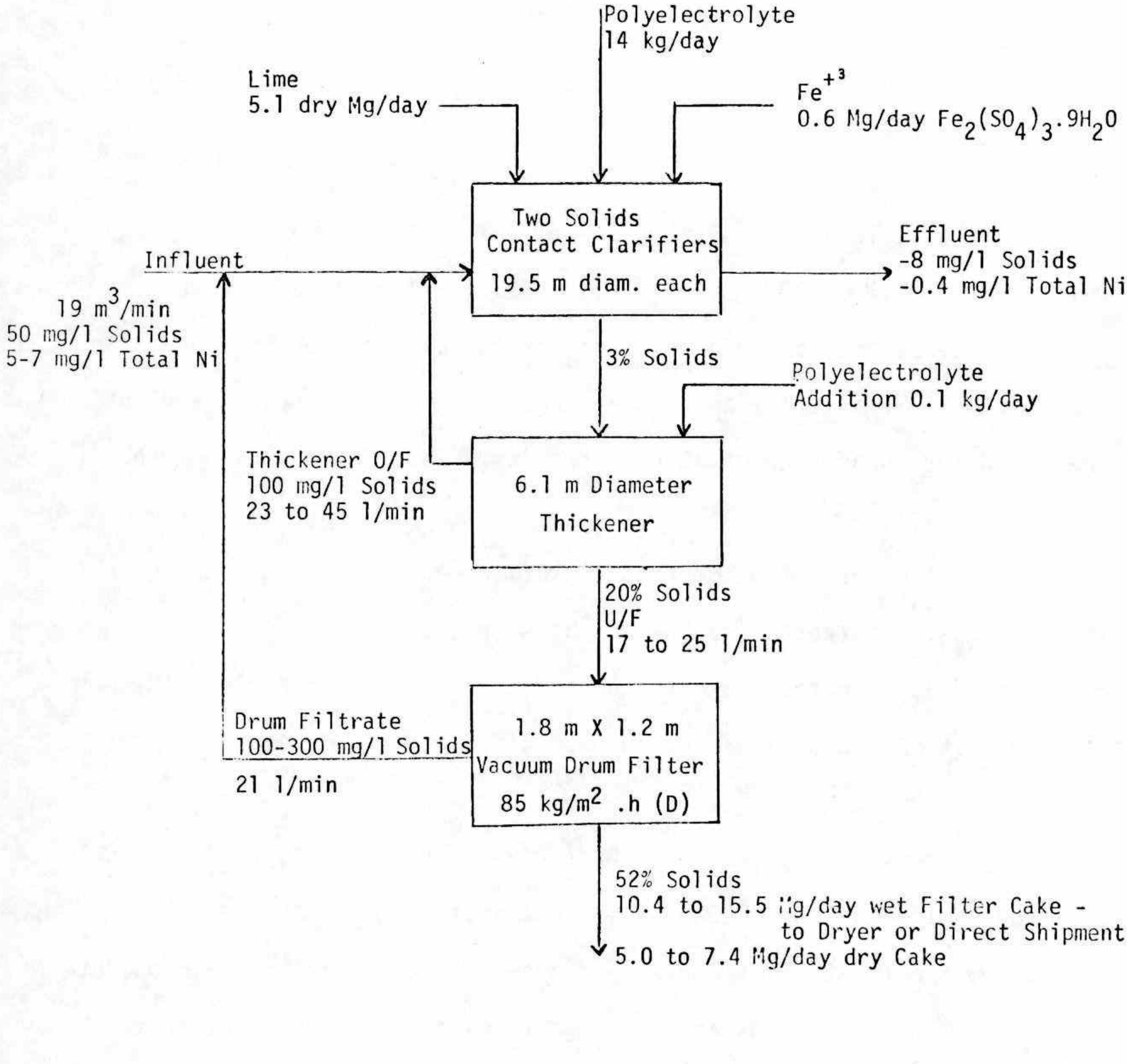
The circuit recommended to operations is shown in Figure 3.

The sludge-recirculation solids-contact clarification process was selected because of:

- -Ease of operation
- -Stability of the operating plant
- -Cost
- -Ability to consistently meet the Ontario Ministry of the Environment Criteria.

Figure 3

RECOMMENDED CIRCUIT



Engineering data were established during the pilot plant operation for:

- Reagent Consumption
- Unit Operations
- Materials Selection
- Instrumentation
- Manpower Requirements
- Special Operation Details

EFFLUENT TREATMENT

The Effluent Treatment system at Port Colborne has been designed and located to collect 100% of the effluents from the nickel refinery, research stations and the adjacent urban area. The refinery effluent flow to the Effluent Treatment Plant has averaged 1000 m^3/h whereas the plant is designed for an average of 1350 m^3/hr with a peak flow of 2170 m^3/h.

The two 21 meter solids contact-clarifiers are, of course, the heart of the process. Control of raw water rates, pH, polyelectrolyte, flocculant addition rates, rake torque and the solids contents within the solids-contact area are necessary to produce an acceptable overflow.

During the hydrology study, it became apparent that the plant drainage system could store up to 100,000 cubic meters of water. The reservoir ahead of the treatment plant markedly reduces the potential need to operate the treatment plant at rates above design flows during periods of heavy run off.

During the evaluation of the solids-contact clarifiers, Inco decided to employ 2 units rather than a single unit. The two unit approach provides continuous treatment of refinery effluent during maintenance and also increases operating flexibility.

Proper control requires extensive instrumentation. The instrumentation and control circuits in this plant accounted for approximately 10 percent of the $5,000,000 total plant cost.

The instrumentation provides for the measurement, control and in most cases the recording of the following:

Influent Water

-Flow rate to each clarifier

-pH

-Temperature

-Potential

-Forebay (Water level)

Solids Contact Clarifier

-pH in the reaction zone (controlled)

-Solids content in the reaction zone

-Rake torque

-Effluent pH

-Effluent clarity (solids)

-Effluent nickel content (continuous analysis)

-Underflow withdrawal time

Lime Slurry

-Solids content

Polyelectrolyte and Flocculant Addition

The addition rate of these chemicals is automatically ratioed to the influent water flow rate.

The plant operation is controlled from the central control room and is remotely monitored by personnel at our Power House.

The lime, polyelectrolyte and ferric iron are consumed at 200 g, 0.7 g and 6 g per 100 m^3 of water; respectively. The lime and polyelectrolyte are received dry and slurried on site. The ferric iron is received as a liquid via tank trucks.

The operation produces ≈9000 kg of solids per day. The final thickened underflow is dewatered on a rotary vacuum drum filter to ≈50% solids. This cake is returned to Inco facilities in Copper Cliff.

CONCLUSION

The treatment plant has now been in operation some nine months. The effectiveness of the plant is indicated by the fact that the effluent concentration averaged some 0.5 mg/l nickel since startup. We believe this 96% reduction in nickel discharged in the effluent demonstrates Inco's ongoing program of environmental improvement. The plant is a tribute to

the research, engineering and operating personnel at the Port Colborne Nickel Refinery.

WATER USAGE AND TREATMENT AT A MODERN STEEL PLANT

by

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1. INTRODUCTION

In June 1980 Stelco Inc. started up a new steelmaking plant on the north shore of Lake Erie near the Village of Nanticoke. The Lake Erie Works (L.E.W.) is the first major green field site development by a Canadian steelmaker. For this undertaking, 2670 ha of land was assembled. The southernmost 1660 ha will be used for steel plant development and the remaining acreage to the north is reserved for an industrial park.

While the site has room to accommodate a steel plant with a capacity of more than 10 million tonnes, expansion to this level will be gradual as market conditions warrant it. As a first step, about 730 ha has been used to build:

- A dock to receive raw materials
- A blast furnace to make iron
- A steelmaking shop
- A continuous slab casting facility
- Material storage
- Environmental control systems
- Landscaping
- Service Facilities

We are now adding a coke-making and by-product plant. Construction should be completed this year. As well, a hot strip rolling mill is being built and should be operating in 1983. By then over $1 Billion will have been invested.

Creating a steel complex and meeting the environmental challenge required careful planning. In this regard, decisions were made early to protect air and water environments and integrate controls with process design. We have taken into account the sensitivities of the water regime adjacent to the plant and the rural background of the area.

Here is how we changed ideas into a modern steelmaking complex and managed our water resource.

Water is used extensively in a steel plant. All of our water comes from Lake Erie and after use, cleaned water is returned. The water is piped to the plant by the Ministry of the Environment and we pay for it. From the beginning we recognized the importance of using water wisely to minimize: treatment cost and environmental impact.
For this reason we adopted the following principles:

- Minimize Water Consumption
- Segregate Waste Streams
- Recirculate Clean and Dirty Water
- Provide Local Treatment
- Apply Advance Technology
- Provide Back-up Equipment
- Use a Single Outfall For Process Water
- Monitor Water Quality

2. WATER TREATMENT PLANNING

As a first step, waste streams were identified and grouped on the basis of contaminants, Figure 1. This permitted us to consider separate treatment steps and design each step for a specific purpose. Removing contaminants before releasing the water from a process is desirable for treatment is easier to control and the approach improves success of treatment. Figure 2 gives an overview of the major water sources and locations.

3. SURFACE WATER DISCHARGE

Clean surface water from undeveloped areas is drained to Nanticoke Creek on the eastern perimeter of the plant. All other water goes to a small seasonal creek running through the site on the west. In each instance, water flows through holding ponds to settle solids and to control the rate of discharge. In addition, the ponds are equipped with floating oil booms and underflow discharge ports to ensure floating debris and oil does not escape. The arrangement is a success from environmental and aesthetic standpoints.

4. RAW MATERIALS STORAGE WATER COLLECTION

Large amounts of raw materials such as iron ore pellets, coal, coke, etc. must be stored on site. We need a secure supply of feed materials for the plant during the winter months, when it is not possible to use lake ships for getting the materials from the mines. The storage sites, however, create run-off. We are concerned about the environmental implications and possible treatment cost for handling this type of water. The solution is not to discharge. It is the safest approach and so we built captive holding ponds. Separate ponds were provided for stored raw materials. They were sized to hold more than the annual rainfall from each catchment area. Some of the water will be used for spraying storage piles to control dusting and the balance is allowed to evaporate.

5. NON-CONTACT COOLING WATER USAGE

Heat is fundamental in steelmaking and water cooling plays an important role in controlling heat build-up in equipment. Although this water is not contaminated, we decided to recirculate and reduce the overall impact of the plant on the lake. We circulate hot water over cooling towers and return cooled water to the process. While dissolved salts increase in

concentration by virtue of evaporation, the water is clean enough for discharge without any special treatment. However, wherever possible, the water is used as make-up in other water systems. The principle of multiple water use is applied throughout the plant.

6. SEWAGE TREATMENT

Sewage collection and treatment is completely separate. Major facilities are connected to an in-plant sanitary sewer system and remote locations use holding tanks. All sewage is processed in a standard sewage treatment lagoon. The lagoon is discharged during spring and fall run-off periods when there is a significant flow in Centre Creek. It was assumed that eventually a regional sewage treatment might be built to serve both municipalities and industries in the area.

In total, we required about 14 ha for lagoons throughout the site. They are used extensively as back-up, safety devices, for direct treatment and as part of the landscaping approach. On the other hand, process water treatment requires a lot more sophistication and ingenuity and we dealt with them as follows:

7. PROCESS WATER TREATMENT

Dirty water comes from the blast furnace and steelmaking as blowdown. It's water which must be drained to control deposit-forming substances in equipment. In these two cases, water is used to clean process gases to eliminate air emissions, but in turn pollution shifts to water. The nature of the gases give rise to two different water conditions and for this reason it's beneficial to start with separate treatment but finish it with a common polishing step. In each case, the latest technology was applied in order to meet environmental standards. The important features are:

1. Blast Furnace Gas Cleaning System

The Blast Furnace is set up to operate on recycled water - Figure 3. The gas is cleaned in a highly efficient scrubber for use as a fuel elsewhere in the plant. The water removes:

- Particulates
- Ammonia
- Cyanide
- Phenol

This water is sent to thickeners to settle solids, it's cooled and returned to the scrubber to repeat the cycle. Settling and cooling is sufficient for recycling but the treatment method is inadequate for getting an effluent for discharge. More of the contaminants must be removed - Table 1. This is done in steps at a central Blowdown Treatment Plant - Figure 4.

First the water is clarified to remove heavy metals and solids. Then it is reacted with chlorine to destroy ammonia, phenol and cyanide. The water is now ready for the final polishing step in a common filter plant.

Prior to filtering, water is mixed with other pretreated blowdowns such as steelmaking water to help adjust water pH. Fine tuning is done with either acid or alkali as required. All process water then passes through a dual media sand filter to reduce solids, to the stabilization Pond #4 and then to the Lake - Figure 5.

The treatment method, for destroying ammonia, is more commonly identified as alkaline breakpoint chlorination and it is the first installation in Canada. Since this is new technology for the steel industry, it was necessary to pilot test the chemistry and treatment potential in order to gain confidence that it will work. Detail studies were conducted by our consultants.

2. Steelmaking Gas Cleaning

As in the blast furnace operation, any particulates of iron oxide, lime, etc. in the process gases is scrubbed out with water - Figure 6. Again water is recirculated but cooling is not needed. Solids are removed in thickeners and recovered for future reuse.

Here problems with ammonia and cyanide are not serious - Table 2. Therefore, a simpler blowdown treatment approach is possible. Basically more of the suspended solids have to be removed. This is done in a dedicated reactor clarifier at the Blowdown Treatment Plant.

The clarified water is then mixed with partially treated blast furnace water and filtered as described earlier - Figure 7. As an extra precaution, emergency holding lagoons were built to hold inadequately treated water for reprocessing. Details of combined process water quality are given in Table 3.

8. RESULTS

Our goal was to build a reliable, integrated and efficient water treatment system to handle all types of water. Its only function is to clean used water and return it to the lake. In order to be certain about the effluent quality, we went beyond merely meeting environmental standards by being cautious in our design approaches. Equipment is sized generously, back-up equipment is provided, reprocessing features are available and a test program is in place to monitor water quality.

Finally, here are the results:

1. The Effluent Complies with Policy 5 of The Ministry of the Environment, Water Management Goals.

2. Pond #4 Water Chemistry Is Acceptable
   Table 4

3. Pond #4 Water Is Not Toxic To Fish
   Table 5

4. No Sublethal Effects Were Identified

5. $57 Million For Water Cleaning Was Spent
   Table 6

6. Final Treatment Cost is 0.0265 cents per litre
   Table 7

9. CONCLUSION

Planning early was important and integrating water treatment with process design was essential. Using advanced technology not fully proven introduces risks but they were minimized by pilot studies. In order to meet environmental standards, water treatment requires the best engineering designs and safety features but the undertaking is expensive. To get clean effluent water is a top priority at L.E.W. It requires skilled people to make a success. In our view, we have risen to the challenge, solved some vexing problems and now have settled down to go fishing.

FIG 1

WATER SOURCES AND FLOW.

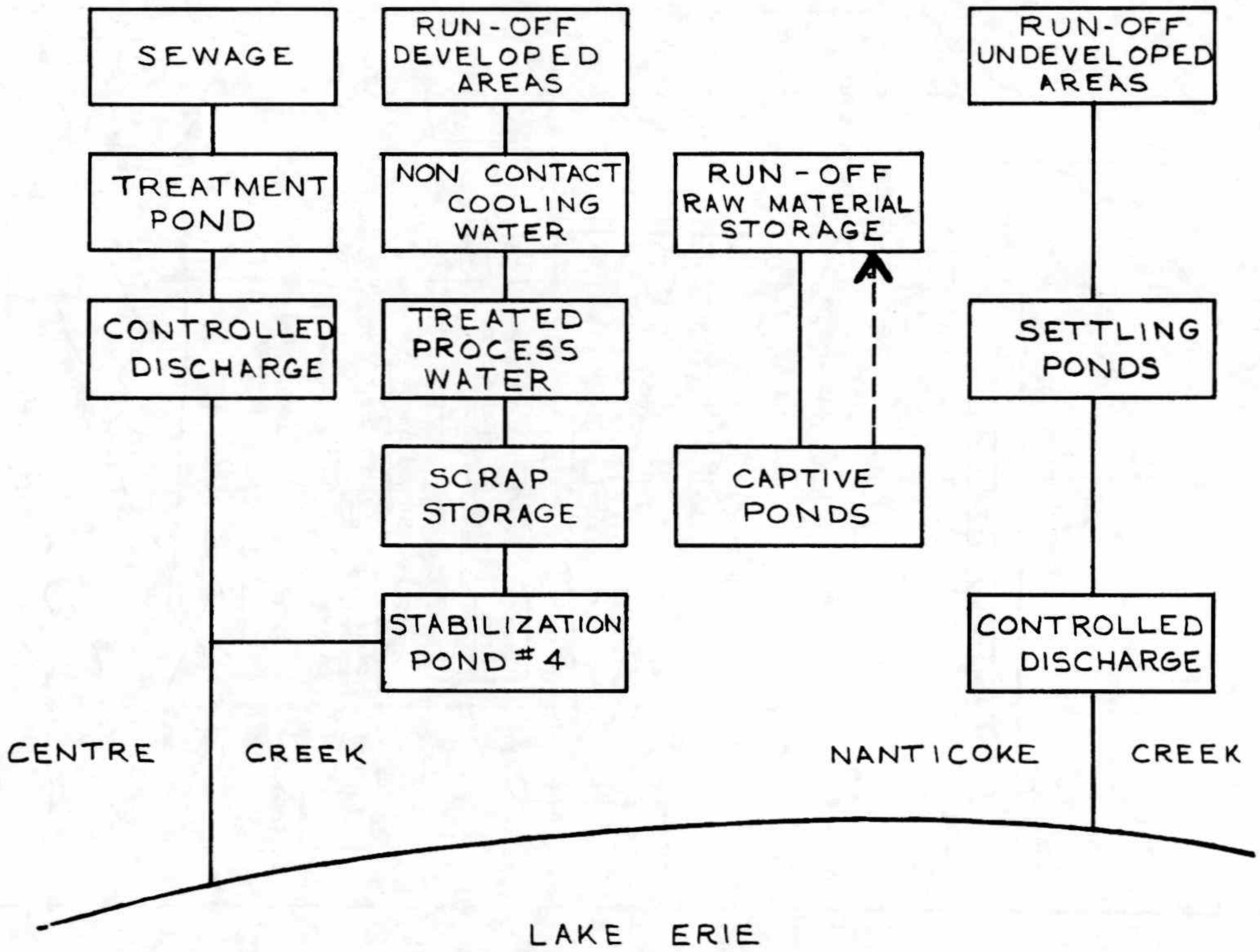
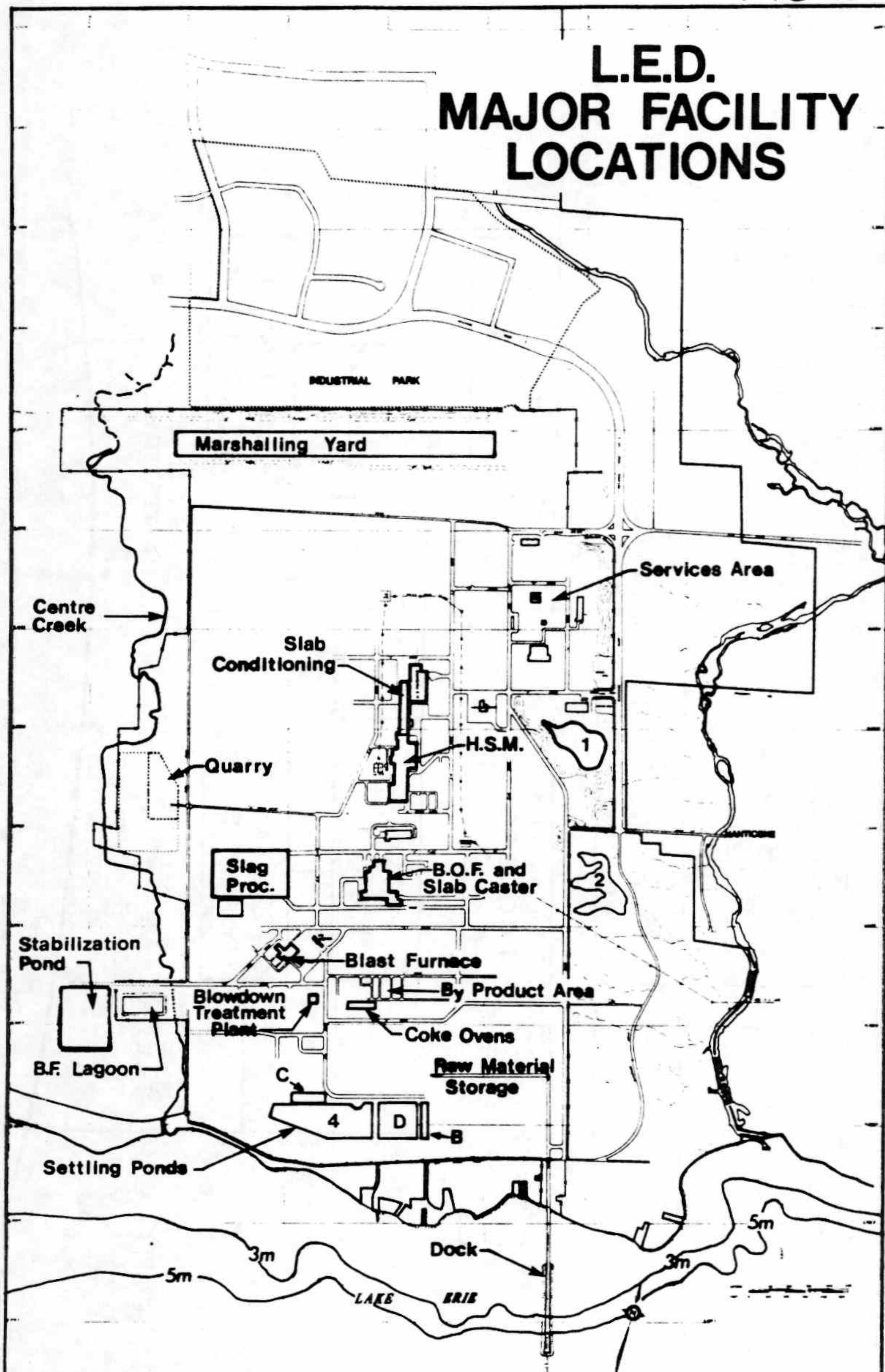


FIG 2



L.E.D.
MAJOR FACILITY
LOCATIONS
INDUSTRIAL PARK
Marshalling Yard
Services Area
Centre Creek
Slab Conditioning
H.S.M.
1
Quarry
Slag Proc.
B.O.F. and Slab Caster
2
Stabilization Pond
Blast Furnace
By Product Area
Blowdown Treatment Plant
Coke Ovens
B.F. Lagoon
Raw Material Storage
C
4
D
B
Settling Ponds
Dock
3m
5m
LAKE ERIE
Scale=1:30,000

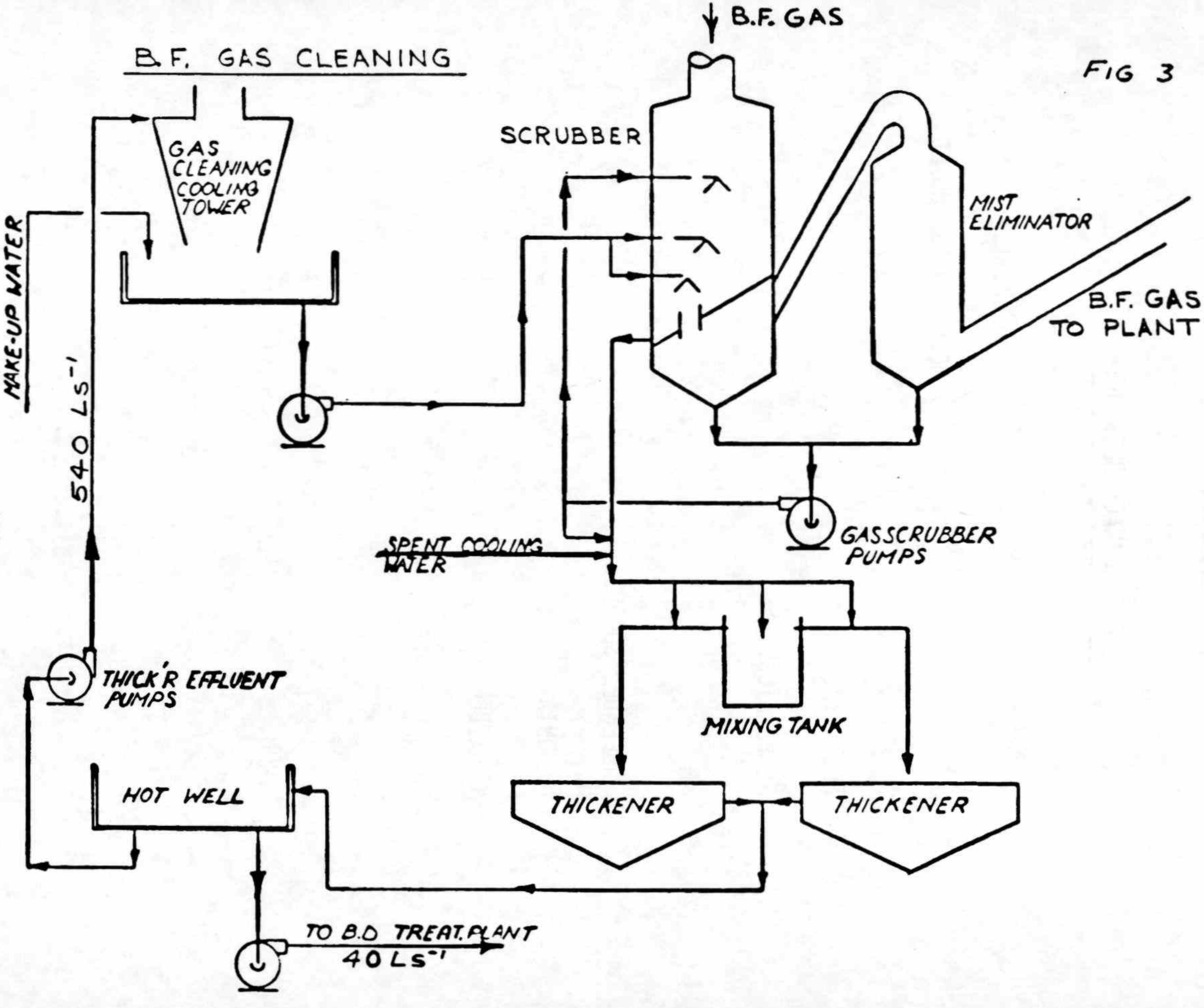

B.F. GAS
B.F. GAS CLEANING
FIG 3
GAS CLEANING COOLING TOWER
SCRUBBER
MIST ELIMINATOR
B.F. GAS TO PLANT
MAKE-UP WATER
540 Ls⁻¹
GASSCRUBBER PUMPS
SPENT COOLING WATER
MIXING TANK
THICK'R EFFLUENT PUMPS
HOT WELL
THICKENER
THICKENER
TO B.D TREAT. PLANT
40 Ls⁻¹

TABLE 1

BLAST FURNACE BLOWDOWN

	OPERATION MG/L UNLESS NOTED
FLOW 1/S	40
TEMPERATURE ^{0}C	18 - 31
pH	7.6
SUSPENDED SOLIDS	109
AMMONIA	23.75
CYANIDE	20
PHENOL	0.035
ZINC	1
IRON	8

FIG 4

BLOWDOWN TREATMENT PLANT.

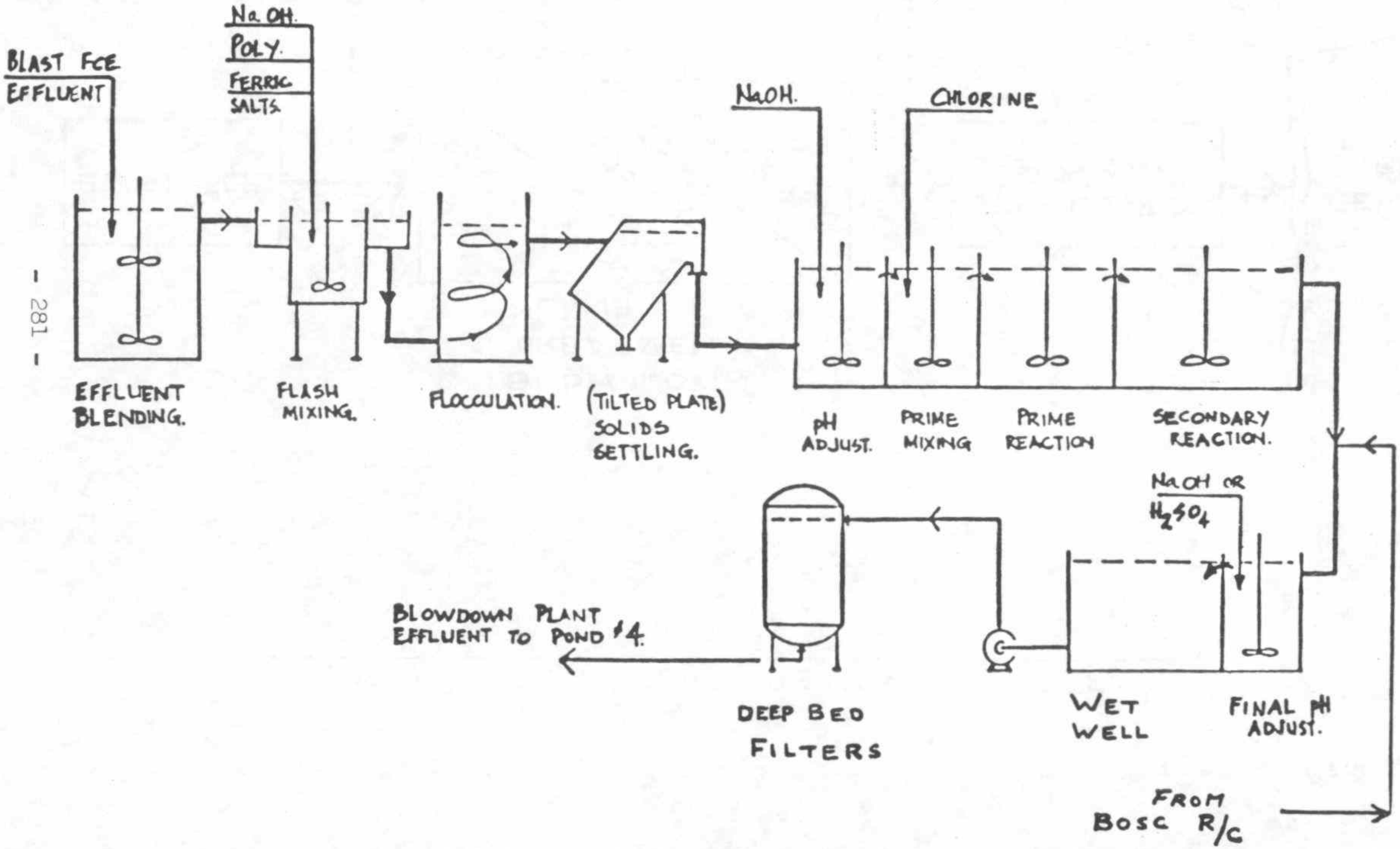
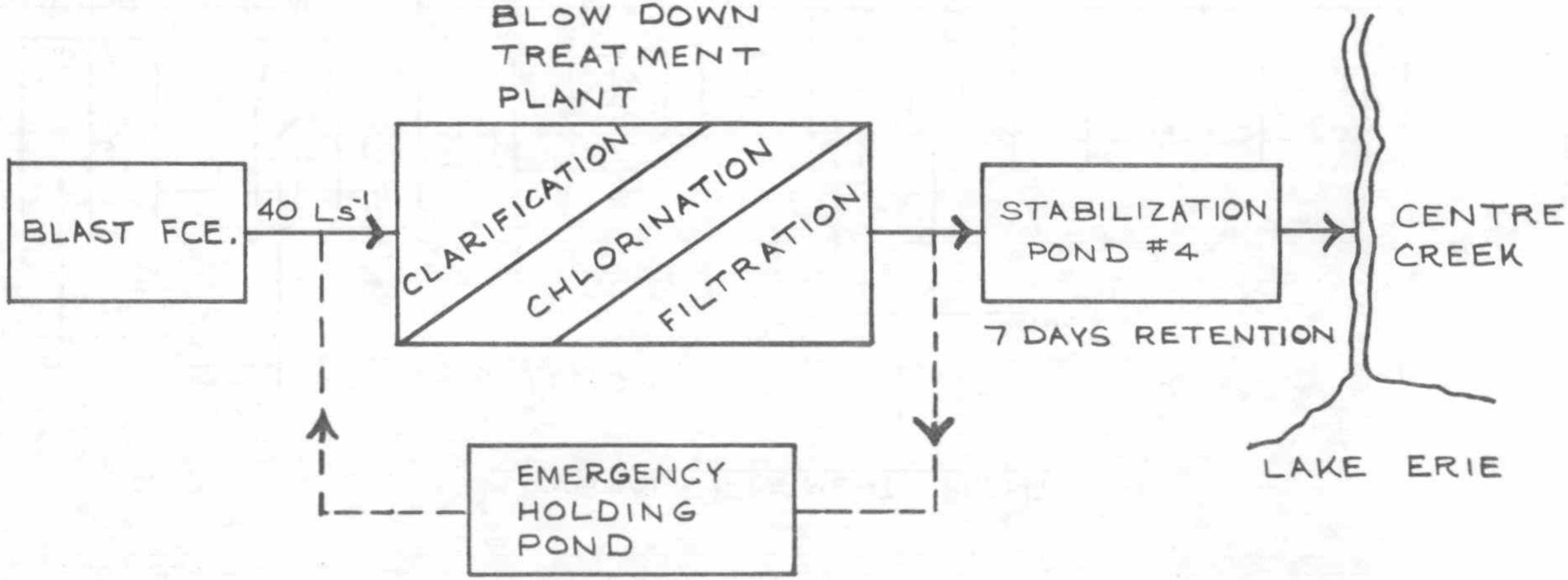


FIG 5

BLAST FCE. WATER TREATMENT STEPS



B.O.F. GAS CLEANING

FIG 6

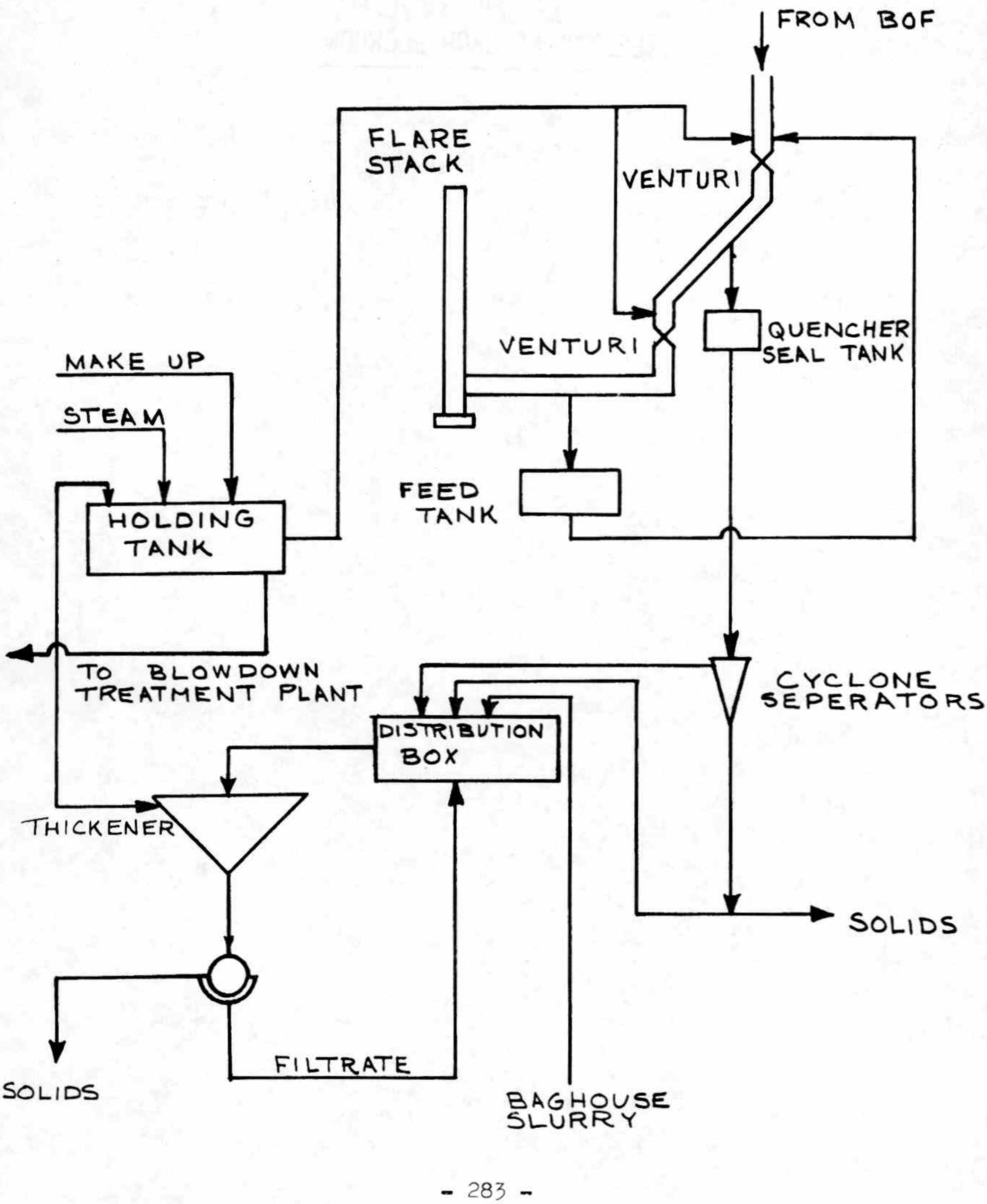


TABLE 2

STEELMAKING SHOP BLOWDOWN

	OPERATION
	MG/1 UNLESS NOTED
FLOW 1/S	75
TEMPERATURE ^{0}C	25 - 39
pH	8.5
SUSPENDED SOLIDS	34
AMMONIA	0.1
CYANIDE	<0.02
PHENOL	0.002
ZINC	1.7
IRON	11.6

FIG 7

BLOWDOWN TREATMENT

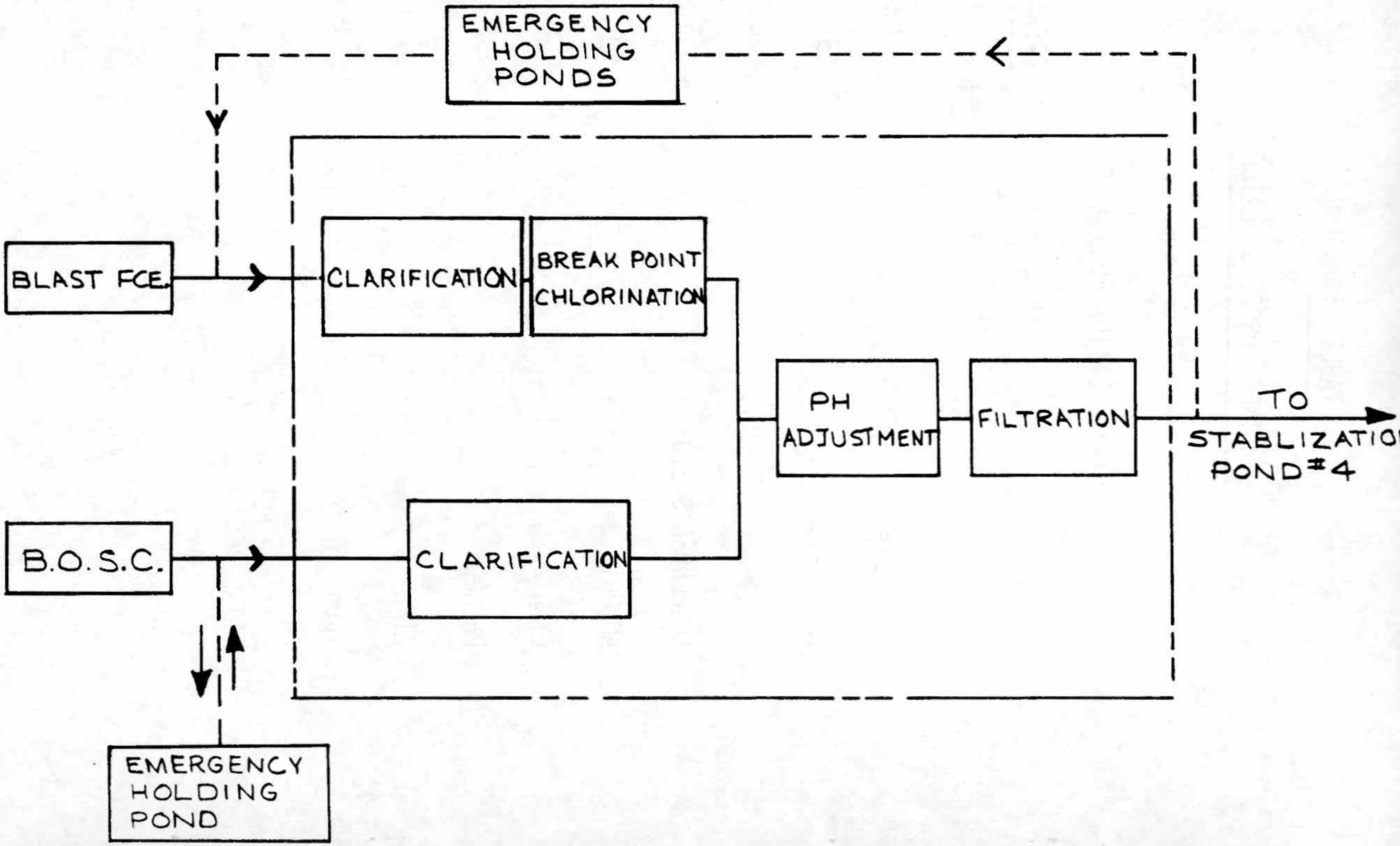


TABLE 3

COMBINED PROCESS WATER

TO

STABILIZATION POND # 4

	OPERATING $mg/_{l}$ unless noted
FLOW 1/s	145
TEMPERATURE ^{o}C	25 - 31
pH	8.2
SUSPENDED SOLIDS	3.9
AMMONIA	0.17
CYANIDE	0.08
PHENOL	< 0.001
ZINC	0.12
IRON	0.66
TOTAL RES. CHLORINE	6.6

TABLE 4

POND # 4 EFFLUENT

	OPERATING MEAN $mg/_{l}$ unless noted
TEMPERATURE ^{o}C	6 - 31
pH	8.30
SUSPENDED SOLIDS	8.53
AMMONIA	0.14
CYANIDE	0.06
PHENOL	< 0.001
ZINC	0.02
IRON	0.64
TOTAL RESID. CL.	NOT DETECTED
OIL	0.75

TABLE 5

Summary of Results

Type of Test	Aquatic Organisms Studied	Results
Static toxicity test at 5%* - 100% effluent.	Rainbow trout, flagfish, freshwater shrimp. Water flea (Daphnia magna).	No mortality at 100%. Mortality at high concentration, no mortality at 5%.*
Flow through toxicity tests 100% effluent.	Rainbow trout.	No mortality.
Respiration and photosynthesis 100% effluent.	Algae (Chlorella vulgaris).	No effect.
Growth and reproduction 5%* - 100% effluent.	Algae (Chlorella vulgaris). Water flea (Daphnia magna).	Biostimulation at 100%, no effect at 5%. No effect at 5%.
Growth studies 5%* 100%	Freshwater shrimp (Gammarus faciatus) rainbow trout	No effect. No effect.
Complete life cycle 5%* effluent.	Flagfish	No effect.
Attraction to or avoidance of effluent 100%.	Rainbow trout, yellow perch, small mouth bass.	No attraction nor avoidance.
Flesh tainting with exposure to effluent, field and 100%.	Yellow perch, rainbow trout.	No effect.
Bioconcentration contaminants, field and 5%* effluent.	Yellow perch, rainbow trout.	No effect.

* 5% effluent concentrations chosen to represent conditions that may be found at the edge of the mixing zone.

TABLE 6

W A T E R   S Y S T E M S
C A P I T A L   C O S T   E S T I M A T E S

BLAST FURNACE	$14 880 000
STEELMAKING	22 860 000
COKE MAKING	6 067 000
BLOWDOWN TREATMENT PLANT	7 105 000
MISCELLANEOUS	6 206 000
T O T A L	$57 118 000

TABLE 7

OPERATING COSTS*

BLOWDOWN TREATMENT PLANT

CHEMICALS	$ 25 600
LABOUR	25 000
MAINTENANCE	46 700
MISCELLANEOUS	2 000
TOTAL	$ 99 300
FLOW	145 l/s
COST PER LITRE	0.0265

* ESTIMATED MONTHLY OPERATING COST BASED ON START-UP